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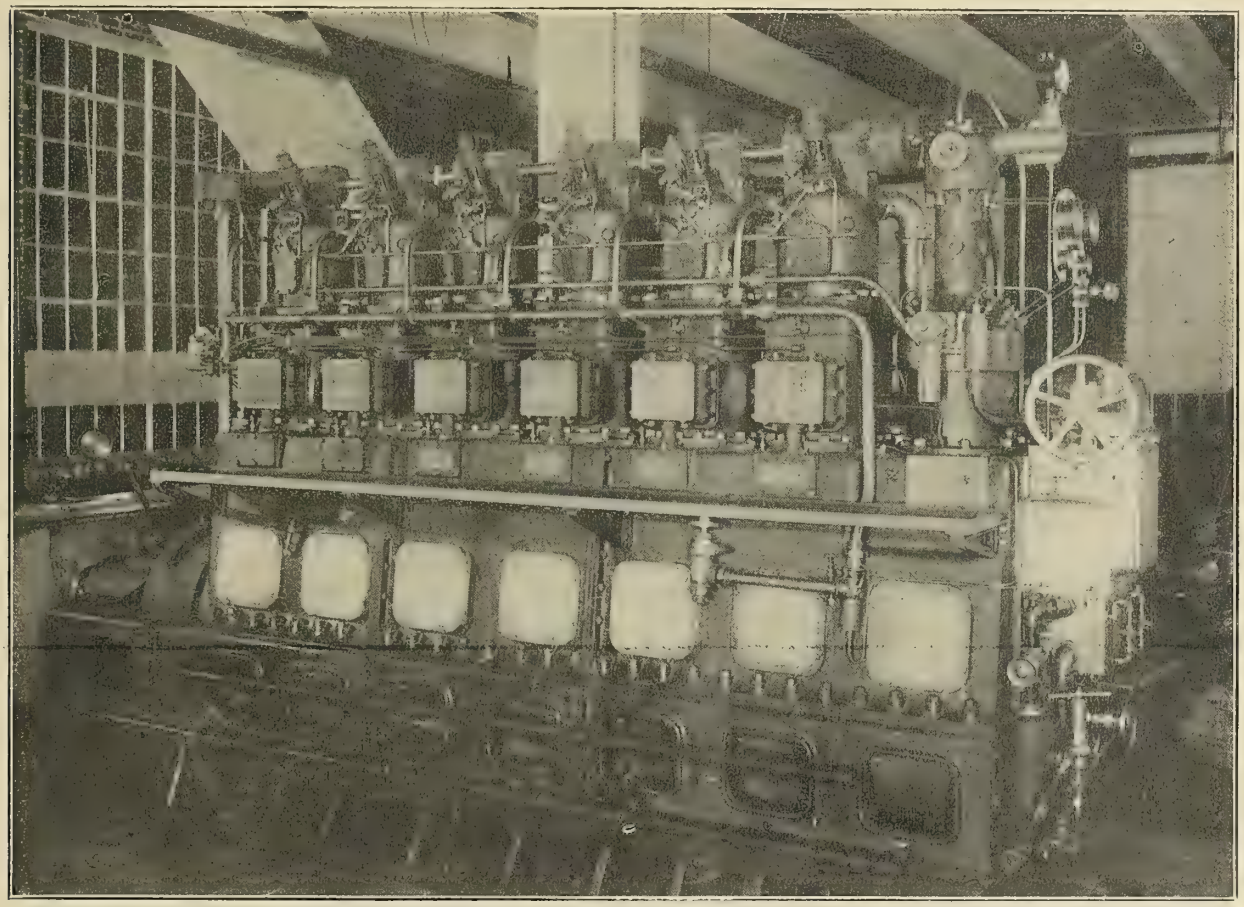
International Marine Engineering

MARCH, 1912

The First American-Built, Diesel-Engined Oil Barge

The Standard Oil Company, New York, is having built a 200-foot steel motor barge of about 1,500 tons deadweight-carrying capacity, in which the propelling machinery consists of a 300-horsepower heavy oil engine, and all the deck and pumping machinery will be operated by oil motors, dispensing entirely with the use of steam in operating the vessel. This is the first American-built vessel to use this type of power, and, in view of the rapid advance which is being made in Europe in the use of this type of propelling machinery, the details of the vessel are of particular interest to American shipbuilders and marine engineers. The hull is being built by the Staten Island Shipbuilding Company, of Port Richmond, New York; the propelling machinery by the New London Ship & Engine Company, Groton, Conn., and the ship will be completed and placed in operation in the spring.

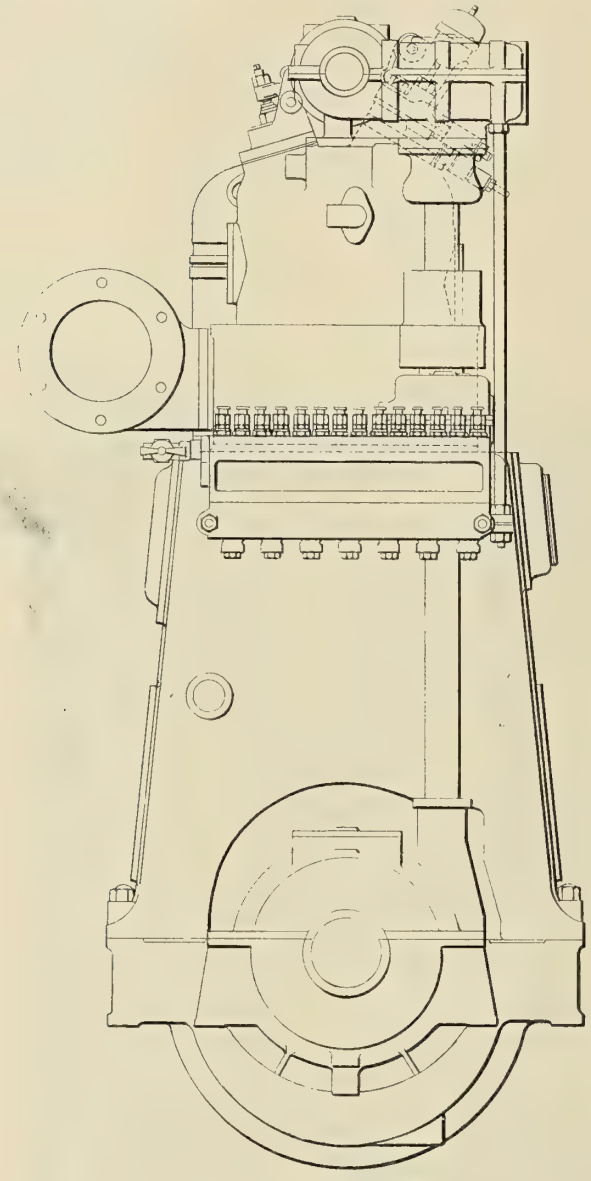


300-HORSEPOWER AMERICAN-NUREMBERG ENGINE FOR THE STANDARD OIL MOTOR BARGE

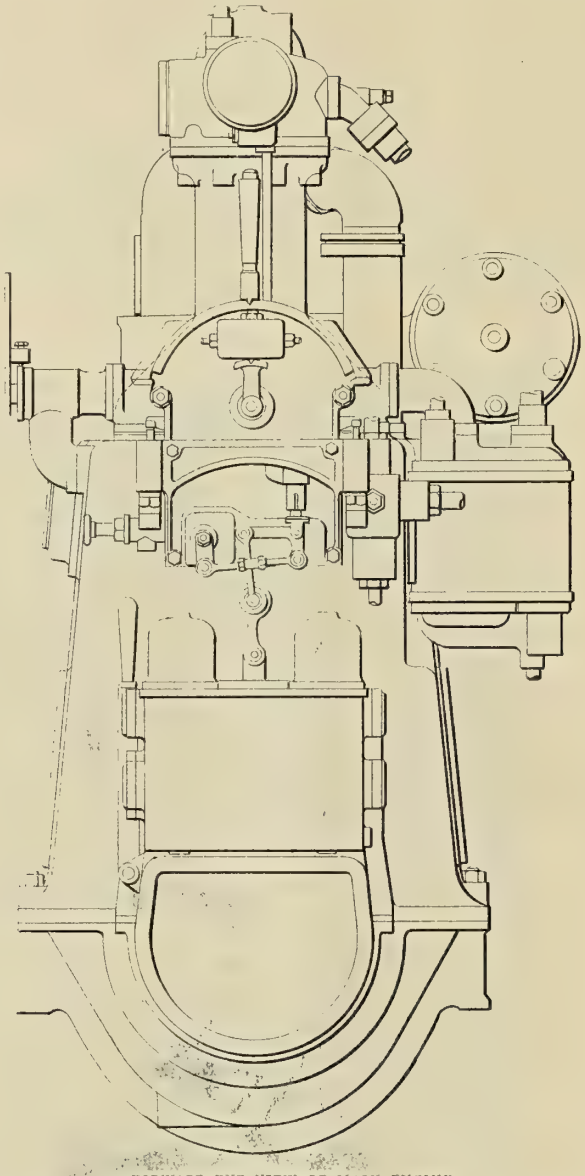
The principal dimensions are: Length between perpendiculars, 200 feet; beam, molded, 35 feet; depth, 15 feet 6 inches. The vessel has a capacity of about 500,000 gallons of oil, or a deadweight-carrying capacity of about 1,500 tons. When fully loaded to a draft of 14 feet, the block coefficient is about .75. The ship was designed to trim 6 inches by the stern when fully loaded.

The design of the vessel follows the usual practice in Standard Oil barges, with the exception of the use of internal combustion engines for supplying power for all purposes on board the ship. The hull is subdivided by nine oil-tight bulkheads into ten compartments. Eight of these compartments are tanks for carrying cargo. The forward compartment contains the cargo pump, chain locker and other equipment. The after compartment contains the propelling machinery, fuel oil tanks and a fresh-water tank. The crew's quarters are contained in a deck house on the main deck above the engine room and around the engine-room hatch, which is 15 feet 9 inches long by 5 feet 2¾ inches wide, covered with a skylight.

On each side of the engine-room casing is a stateroom containing two berths. Aft of the engine-room casing is the mess room and galley. The forward part of the deck house contains two staterooms, one with two berths and the other with one berth and desk for the captain's use. The pilot house is directly over the forward end of the deck house. In the sleeping quarters is installed a heater with connections on both port and starboard sides for connecting to a tug or dock when in port, and there are also connections to the main engine circulating water.



AFT END VIEW OF MAIN ENGINE



FORWARD END VIEW OF MAIN ENGINE

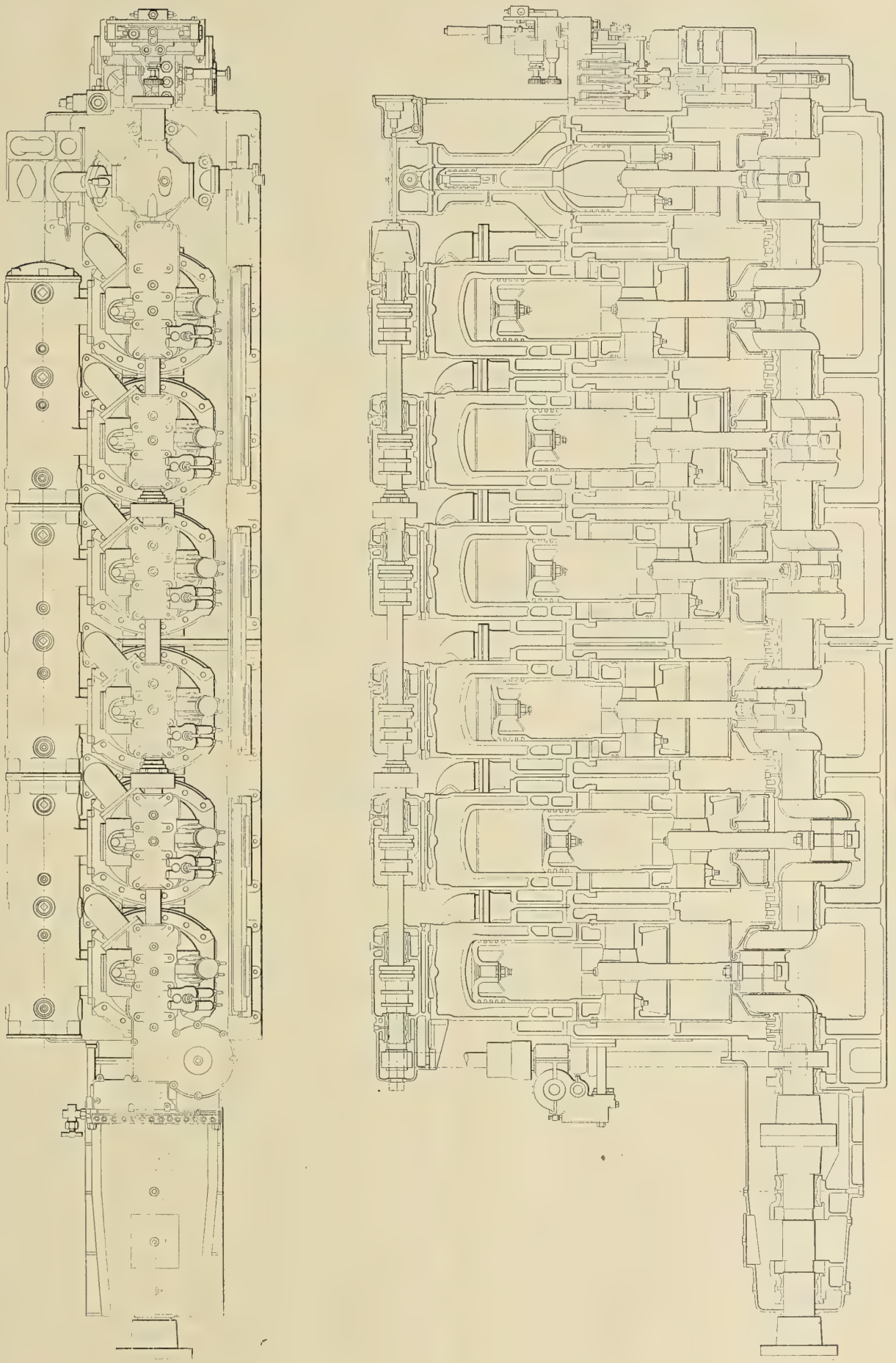
HULL CONSTRUCTION

The main scantlings of the hull are shown on the midship section. The stem and stern post are of forged iron, the stem being 7 inches by 2¼ inches and the stern post 7 inches by 3¼ inches. The frames are bulb angles, 6 inches by 3 inches by 8/20 inch, spaced 24 inches except in the forward compartment, where they are spaced 21 inches, 18 inches and 15 inches, as shown on the general plans. Reverse frames, consisting of 3-inch by 3-inch by 6/20-inch angles, are placed on every floor extending across the tops of the floors. One web frame is placed in each cargo compartment, and in the forward compartment there are two web frames. The web frames are built of plate, 18 inches wide by 7/20 inch thick, with 3-inch by 3-inch by 6/20-inch angles on the face. Keelsons and stringers are placed, as shown, on the midship section, except that there are extra side stringers in the forward compartment, two on each side, extending from the forward oil bulkhead to the stem. They are made of 6-inch by 3-inch by 8/20-inch bulb angles.

The nine transverse bulkheads are built of 6/20-inch plate with 8/20-inch floors, and are stiffened by vertical angles, 4 inches by 3 inches by 7/20 inch, spaced about 20 inches. Three web stiffeners, 24 inches by 7/20 inch at the bottom, reduced to 15 inches by 7/20 inch at the top, with double 3-inch by 3-inch by 6/20-inch angles at the edge, are worked on each bulkhead in the position shown on the general arrangement plans. These web stiffeners are connected to the bulkheads by 3-inch by 3-inch by 7/20-inch angles. One horizontal stiffener of 7/20-inch plate, with 5-inch by 3-inch by 8/20-inch angles on the inner edge, is worked intercostally between the webs and shell. This stiffener is connected to the bulkhead by 3-inch by 3-inch by 7/20-inch angles. The end bulkheads in the oil space have web stiffeners 50 percent deeper than those on other bulkheads.

Hold beams, 6 inches by 3 inches by 8/20 inch bulb angles, are located as shown on the plans at each web frame.

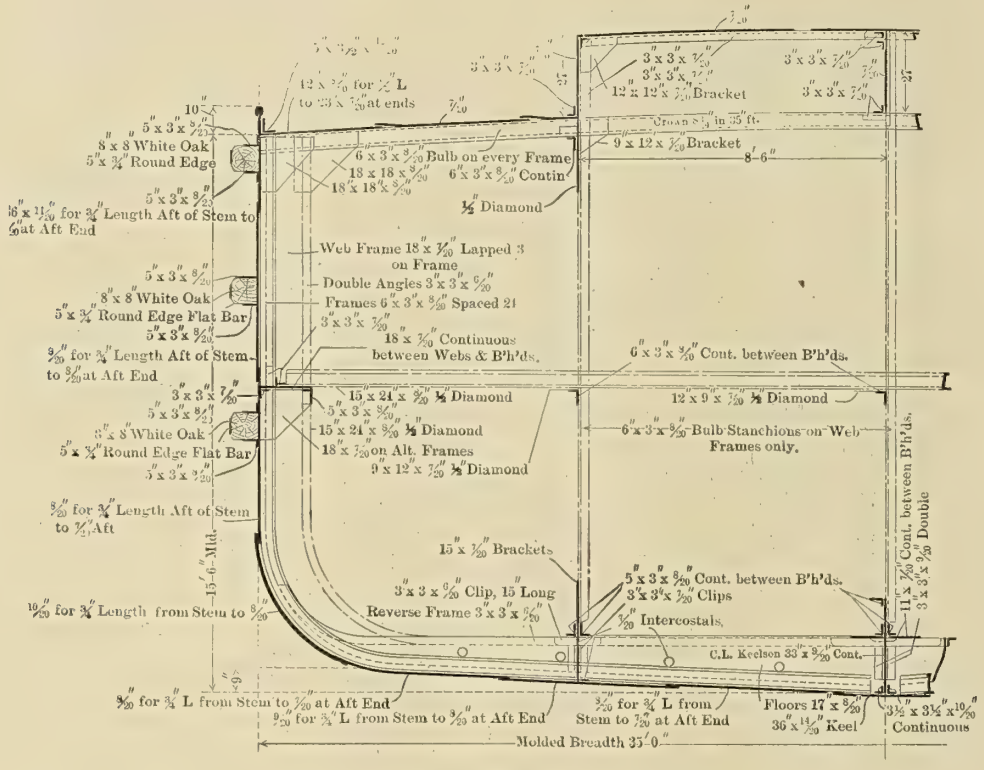
The expansion trunk is 17 feet wide by 27 inches high, as shown on the plans. Swash plates are placed above the deck



SECTIONAL VIEW OF 300-HORSEPOWER DIESEL ENGINE FOR THE STANDARD OIL MOTOR BARGE

under the expansion trunk on the center line, and ridge bars are located on each side of the trunk. These are all continuous between bulkheads. Cargo hatches 4 feet square are located as shown on the deck plan. There is one 4-inch relief valve and one 10-inch manhole on the expansion trunk for each oil compartment. The cargo main is of 8-inch wrought iron pipe, with one 6-inch, one 4-inch and one 3-inch valve and bell-mouth suction in each compartment. Loading connections are located forward and aft on both sides, and there is also a 6-inch independent loading line in each compartment leading from the top of the expansion tank to the bottom of the barge.

The windlass and the oil pump are driven by a 25-horsepower oil engine, located on the deck forward, and driving a


12" x 12" x 7/20" Bracket
3" x 3" x 7/20"
Crown 8 1/2" in 35 ft.
9" x 12" x 7/20" Bracket
8'-6"
6" x 3" x 8/20" Bulb on every Frame
18" x 18" x 8/20"
6" x 3" x 8/20" Contin
1/2" Diamond
Web Frame 18" x 7/20" Lapped 3 on Frame
Double Angles 3" x 3" x 6/20"
Frames 6" x 3" x 8/20" Spaced 24
3" x 3" x 7/20"
18" x 7/20" Continuous between Webs & B'h'ds.
6" x 3" x 8/20" Cont. between B'h'ds.
15" x 24" x 8/20" 1/2 Diamond
12" x 9" x 7/20" 1/2 Diamond
18" x 7/20" on Alt. Frames
9" x 12" x 7/20" 1/2 Diamond
6" x 3" x 8/20" Bulb Stanchions on Web Frames only.
15" x 1/20" Brackets
3" x 3" x 6/20" Clip, 15" Long
Reverse Frame 3" x 3" x 6/20"
5" x 3" x 8/20" Cont. between B'h'ds.
3" x 3" x 7/20" Clips
1/20" Intercostals
C.L. Keelson 33" x 8/20" Cont.
11" x 7/20" Cont. between B'h'ds.
3" x 3" x 8/20" Double
Floors 17" x 8/20"
36" x 14/20" Keel
3 1/2" x 3 1/4" x 10/20" Continuous
Molded Breadth 35'-0"

MIDSHIP SECTION

countershaft, which is provided with a clutch and geared to the windlass on the deck and the cargo pump in the forward compartment. Bilge pumps to draw water from the ends of the barge are hand pumps of the Cataract type with 3-inch suctions. The engine room bilge pump is driven off the main propelling engine, as will be explained later.

Propelling Machinery

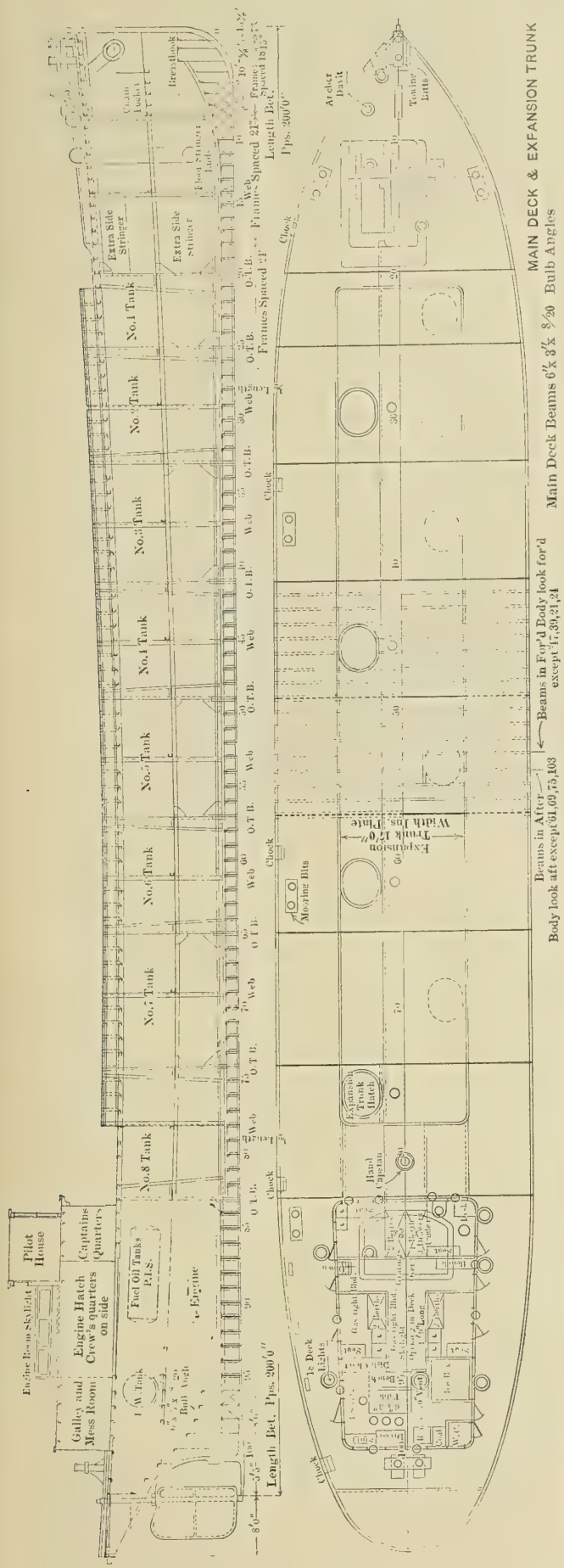
The main engine is a heavy oil internal-combustion engine of the type manufactured by the Maschinenfabrik Augsburg-Nürnberg Company, of Nuremberg, Germany, of which the New London Ship & Engine Company, Groton, Conn., is the American licensee. It is a two-cycle Diesel engine, with six working cylinders and a two-stage air compressor on the bedplate. As is common with large Diesel engines, starting and reversing is accomplished by compressed air, and the fuel oil is sprayed into the cylinders by compressed air and ignited by the heat of the fresh charge of air compressed in the working cylinder during the up-stroke. Each working cylinder is supplied with an independent scavenging pump to clear the cylinder of the burnt gases.

The working cylinders are 9 1/16 inches diameter, 15¾ inches stroke. The engine is designed to operate at 300 revolutions per minute, developing 300 horsepower. On a 200-hour trial of this engine the brake-horsepower actually developed was 374 at 300 revolutions per minute, the fuel consumption being about ½ pound per horsepower-hour.

As will be seen from the drawings of the main engine, step pistons of the trunk type are used; that is, the working piston is prolonged and enlarged to serve as the piston for the scavenging pump. This arrangement takes care of the thrust from the connecting rod and guides the piston. Such a design, of course, increases the height of the engine, but it decreases the length and also the cost and weight of the engine by combining the working pistons and scavenging pump pistons. Each working cylinder, therefore, has its own scavenging pump, which supplies air at a pressure of about 7 pounds per square inch into a reservoir in the upper part of the crank case for clearing out the working cylinders on each stroke. As shown in the drawing the working piston and scavenging pump piston are a solid casting, but in the latest design of this engine we understand that the working piston and pump piston are cast separately and joined by bolts to permit dismantling the engine more readily.

Forced lubrication is used, the pumping arrangement being located on the after part of the engine, the oil being led through the hollow crankshaft and up the connecting rods to the gudgeon pins, where the oil is carried through tubes to the heads of the working pistons, and circulates through spaces in heads of the pistons for cooling purposes. The oil flows by gravity to the crank-pit, and after it is cooled and filtered it is again circulated through the lubricating system. Shields are fitted for the crank webs to prevent an excess amount of oil reaching the scavenging pumps.

Each working cylinder has three valves in the head of the cylinder, one being for the admission of fuel, one for scavenging air, and one for admitting compressed air. The latter is controlled by two plungers, one for starting the engine ahead and the other for starting astern. All the valves are cased in, and a single cam-shaft runs along the tops of the


MAIN DECK & EXPANSION TRUNK
Main Deck Beams 6"x 3½"x 8/20 Bulb Angles
Beams in For'd Body look for'd except 17,39,21,24
Beams in After Body look aft except 61,69,75,103
INBOARD PROFILE AND DECK PLAN
Length Bet. Pps. 200'0"
Pilot House
Engine Hatch Crew's quarters on side
Fuel Oil Tanks P.&S.
Engine
Gallley and Mess Room
No.1 Tank
No.2 Tank
No.3 Tank
No.4 Tank
No.5 Tank
No.6 Tank
No.7 Tank
No.8 Tank
Mooring Bitt
Expansion Trunk Hatch
Anchor
Hawse Pipes
Capstan
Steering Gear
Engine Room Skylight
Bath
Officers Mess Room
Pantry
Chief Engr.
Asst. Engr.
Engr.
Asst. Engr.
Engr.
Asst. Engr.

This movement of the engagement of the disk is performed by the movement of the single control lever.

The control lever which is shown on the drawing in the mid position can be moved in two ways, one which starts the engine ahead and the other astern. Moving the lever through an angle of about 45 degrees admits compressed air to the air-starting valve control plungers, and the engine operates on the compressed air. As the lever is moved beyond this intermediate point the fuel oil is automatically admitted and the compressed air shut off, so that combustion begins to take place in the working cylinders before the operation on compressed air has entirely ceased. This method of control by the movement of a single lever makes the action of the engine positive, and does not give the engineer an opportunity to make any mistakes. He simply has to pull the lever from one side to the other according to orders, and the various operations are automatically carried out by the compressed air control on the valves until the engine takes up the work, the compressed air for starting being cut off and the supply of fuel gradually increased.

The air compressor, as shown in the drawing, is a two-stage compressor in a single cylinder, which delivers air at about 800 pounds per square inch into an air reservoir alongside the engine. Surplus air is led from this reservoir to other tanks, which are kept in order to furnish a sufficient supply for maneuvering.

The engine is supplied with a roller-thrust bearing and a jaw clutch for connection to the propeller shaft, so that the engine can be disconnected and run independently of the propeller when desired. The engine room bilge pump is driven direct from the crankshaft, and part of the circulating water is to be used for heating the sleeping quarters.

This engine has been completed and given a thorough testing in the builders' shops. After a 200-hour test, when the engine operated very satisfactorily, it was dismantled, and all the moving parts were found in splendid condition.

The weight of the engine complete is 28,000 pounds. The fuel oil is carried in two tanks, one on the starboard and one on the port side of the engine room, each having a capacity of 1,100 gallons. There is also a 750-gallon fresh water tank in the engine room and a 250-gallon lubricating oil tank.

The performance of this ship will be awaited with exceptional interest, because the engine is of a type which has already been built in Germany in units up to 12,000 horsepower and bids fair to give unusual results in the matter of economy.

Rapid Work on the U. S. Collier Orion

A good example of rapid ship construction is evident from the photograph shown herewith, which was taken two months after the keel of the vessel was laid. The vessel was the collier *Orion*, which the Maryland Steel Company, Sparrows Point, Md., is building for the United States government on the Isherwood system. The contract for this collier was awarded on Aug. 22, 1911; the first material was received at the builders' yard on Sept. 22, and the keel laid on Oct. 6. At the date the photograph was taken over 2,500 tons of material had been assembled and riveted, the cargo holds being entirely completed and the ship in frame from stem to stern post. The plating had proceeded through the cargo holds, and the top side tanks in way of the cargo holds. The builders are well justified in claiming this a record in building for a vessel of this size.

COLLIER ORION TWO MONTHS AFTER LAYING THE KEEL

The general dimensions of the ship are as follows:

Length over all	536 feet.
Length between perpendiculars	514 feet.
Beam, molded	65 feet.
Depth, molded to upper deck	39 feet 6 inches.

Among engineers and commercial authorities there is a conviction that the coming sessions of the Twelfth International Congress of Navigation, to begin in Philadelphia on May 23, will have a deep influence upon waterway projects of national importance that are now in contemplation. This view of the significance of the coming deliberations of world-famous engineers is borne out by a statement made by A. Dufourny, one of the two presidents of the Congress, who is also Inspector-General of the Belgium Corps of Engineers. In touching upon the influence which the Congress has had in the past upon waterways development, Mr. Dufourny makes the statement that the transformation of the Erie Canal for 2,000-ton boats was inspired by ideas developed at the Congress of Vienna. The Congresses of Navigation bring together the engineers and specialists who in all parts of the world have to carry out the works required to adapt canals, ports and rivers to the needs of the public. Each is at these sessions benefited by the knowledge, the studies and the experience which his colleagues have acquired. The questions are treated from broad, general and universal points of view. The union of efforts has brought about in a few years great and rapid advances in the vast domain of hydraulic works.

A Retrospect of Fifteen Years of Ship Design and Construction

BY PROF. C. H. PEABODY

The contest for maritime supremacy on the North Atlantic during the last fifteen years has excited a keen general interest, even a sporting interest, as each new competitor snatched the record only to yield it to a larger and swifter ship. The race is no new thing, but the zest has been the greater because there has been a general as well as a professional appreciation that we have been approaching the grand culmination of the strife. A sober review of the situation will the better enable us to grasp the meaning of the contest and the magnitude of the success.

Twenty years ago there were two classes of steamers—passenger steamers and freighters. All steamers carried freight as an important if not the principal business, but passenger steamers sought a regularity and a speed that would attract passengers. The *Servia,* which was a good ship in her day, may serve as an advanced type of the passenger ship. She was 517 feet long, had over 9,000 horsepower, and could do better than 16 knots at sea; a good, reputable speed even to-day on any other course than the North Atlantic. Such a ship could go anywhere, without paying much attention to wind or weather, and carry her passengers with safety and comfort. It is true that a prudent master would respect winter gales, but he knew it meant only a day or two extra on the passage. It is fair to say that the shipbuilder had conquered the ocean and that the navigator feared nothing but the land.

But the transatlantic lines had a clear grasp of the idea that the record for the fastest ship was worth money, and that people were ready to pay roundly for the éclat of traveling by the ship that held the record and for the privilege of enjoying a day less on the passage. So there was built up the great fleet of express steamers, the pioneers of progress in shipbuilding, that developed and paid for the advantages that now are to be had by all travelers by sea.

Express Steamers

As a full-developed type of express steamer let us choose the *Campania,* which was completed in 1893, and therefore antedates our fifteen years by four years, but which held the record well into our period. She was 600 feet long, had 31,000 horsepower and made 23 knots. In displacement she was nearly twice as large as the *Servia,* and she had more than three times as much power, and (roughly) went half again as fast. It is clear that in order that the owners could recoup their expenses the passengers must pay roundly for a relatively small advantage. At first blush it would not appear that the record-breaker was so very much of a credit to the builders after all. In order to understand what had been accomplished and how great a triumph of engineering skill the *Campania* really was, we must look a little into the elementary theory of the effect of size on speed.

Now, the controlling element for speed of well-formed ships is length, and it is only when an intelligent understanding of this relation is kept in mind that we can judge of the success of any new record-breaker. William Froude long ago laid down the law that the relative speeds of ships were proportional to the square roots of their lengths. If then the *Campania* were simply a longer *Servia* her speed should be $\frac{\sqrt{600}}{\sqrt{517}} = 1.08$ as great; that is, there would be a gain of about 8 percent. If the *Servia* could be credited with a trial speed of 16.7 knots the greater *Servia* would have 18 knots, whereas the *Campania* made 23 knots. Now we begin to see why she had to pay the price for holding the record for a few seasons.

In 1900 the record passed to the German lines, a matter to be well considered, for the Germans are a comparatively new people in the competition. The *Deutschland* raised the speed to 23.5 knots by increasing the length to 663 feet and the power to 36,000. The newer German ships were larger but not faster, and so the matter rested till new elements entered the competition.

For reasons of State the British Admiralty concluded that it was not well to have any steamers afloat that they could not catch, and so arranged a special subvention for the building of the *Lusitania* and the *Mauretania,* which would appear as auxiliary cruisers should there be danger that peace would be broken. Both peace maneuvers and war experience have shown that the express steamer is hard to drive away. True, she does not await the coming of a cruiser, but when the cruiser turns back to regain touch with the fleet so also does she, and remains just beyond range. The British Admiralty having now a number of battle cruisers that do 25 knots or better, the subvention of express auxiliary cruisers cannot be looked for as a stimulus to a renewal of the race for the Atlantic record.

The most striking feature of these express steamers is, after all, not their great size nor their exceptional speed, but the application of turbines to propulsion on so large a scale and so soon after the development of the marine steam turbine. But this story, which would be extravagant if it were not true, is given by another writer in this number of International Marine Engineering. To that writer may be left the question whether the enormous 70,000 horsepower of these ships would be possible with reciprocating engines.

Speed-Length Ratio

A most useful method of comparison of speeds of ships is the speed-length ratio; that is to say, the ratio of the speed of the ship in knots to the square root of the length of the ship in feet. Algebraically, this is represented by the expression $\frac{V}{\sqrt{L}}$, where V is the speed in knots and L is the length in feet. Applied to the *Campania* this gives $\frac{23}{\sqrt{600}} = 0.9$, and all the successive record breakers up to the *Lusitania* have the same value for the speed-length ratio, so that they were straight examples of out-building. With some reservation it may be said that the record may always be won by the expedient of building a larger and more powerful ship if the shipbuilder is given a free hand.

Now the *Mauretania* attained a speed of 26 knots on trial, with a length of 760 feet. Applying the test just stated, it is clear that she is more than a larger *Campania,* for her speed-length ratio is $\frac{26}{\sqrt{760}} = 0.94$, which shows that in a certain sense she is a better ship as well as larger.

Have we then arrived at a finality? In a recent paper before the Society of Naval Architects and Marine Engineers, the distinguished naval architect, Sir William Henry White, indicated clearly that he thinks we have come very near to that

condition. None knows better than he that a new ship might get the record by a narrow margin, following the well-known expedient of out-building, and few know so well the cost of winning in that line. We may easily agree with him that these magnificent steamers fill all reasonable demands for speed and regularity of passage. For example, the *Mauretania* made fifteen round trips in a year, and varied in speed only from 25 knots to 26 knots, meeting in the year all kinds of weather.

In the latest competition for favor on the Atlantic route the *Olympic* and *Titanic* have definitely declined the race for speed, preferring to give their vast size and bulk to convenience and luxury of passenger accommodation and to cargo capacity. Their speed of 21½ knots on trial is, after all, a high speed and obtained with a relatively moderate power. With a length of 850 feet this gives a speed-length ratio of $\frac{21.5}{\sqrt{850}} =$ 0.75, which is a trifle more than that of our old friend the *Servia*. There seems then to be a return to the conservative type of the freight and passenger ship which has found favor on all routes except the North Atlantic. The size of these ships is partially limited by the draft of harbor channels and by the demands of transportation. The great and increasing cost of deepening channels will delay further improvement in that line till the demands of commerce are urgent, and so it may be expected that the immediate future will see a larger increase of numbers of such steamers before much increase in size.

Early Pacific Steamers

At the beginning of our fifteen years of retrospect the voyage to Japan and China was made in a leisurely way by the steamers of the Pacific Mail and the Occidental and Oriental lines, operating conjointly. The former still headed her list of ships by the *Pekin*, built about 1877, and the latter had in service out-classed Atlantic liners like the *Coptic*. The *Pekin* was heavily sparred and depended largely on her sails. On this lonely stretch of water the wail of the Chinese sailors shifting sail in the night was not an unwelcome sound to the passenger, as the writer well remembers. In 1891 the Canadian Pacific Railroad put on the *Empress of India* and two sister ships, credited with a speed of 18 knots on a length of 458 feet; the speed-length ratio was, therefore, about 0.84, which would almost entitle them to rank with express steamers.

But the most pretentious change on the Pacific was the advent of the two Japanese steamship companies—the Toyo Kisen Kaisha and the Nippon Yusen Kaisha, one operating a line to San Francisco and the other to Seattle. These ships, of about 450 feet length and 6,000 tons displacement, have been mostly built in England, but the *Hitachi Maru* was built at Nagasaki for the latter company in 1898. The competition of this race of hardy seamen accustomed to the Oriental scale of wages is likely to be keen and persistent.

Intermediate Ships

Together with the demand for regular and fast passenger steamers, the Atlantic trade has demanded large and fast freighters which have been able to offer superior passenger accommodation with passages of not undue length. These have been called intermediate ships which may be characterized by a speed-length ratio of 0.6 to 0.7. The first issue of International Marine Engineering gives a good example of this type in the *Pennsylvania* with a speed of 14.5 knots on a length of 560 feet; the speed-length ratio is 0.61. To get the passenger accommodation where it would not interfere with the loading and unloading of cargo it was placed well above the water amidships. Passengers who cared little for record breaking, and did not fear a few more days at sea, were quick to learn that these ships were more comfortable than the crowded express steamers. Such a ship as the *Saxonia*, with a speed of 16 knots, could make the Atlantic voyage in eight days and afford every comfort and luxury. Of this class were the *Dakota* and *Minnesota*, built in 1903 by the Great Northern Railroad for the Pacific trade. The loss of the *Dakota* is greatly to be regretted, and still more the conditions which have determined that she will not be replaced. With a sea speed of 14.5 knots on a length of 630 feet the speed-length ratio is 0.58. There is an occasional tendency to class the *Olympic* with these intermediate steamers, but in my opinion such classification is misleading, for though she has an enormous freight capacity she is clearly a passenger steamer, though not of the type of express steamer.

A typical American ship is represented by the coastwise steamer *Madison* of the Old Dominion Line, which differs from the Atlantic liner mainly in size, for a speed of 15¾ knots on a length of 374 feet calls for a speed-length ratio of 0.81, which should qualify for any class except that of express steamer. Having all passenger accommodation on the upper deck these steamers offer quite as much comfort as the Atlantic liners, though there is less ostentation. This type was so well and so early developed that there is to record only a normal growth in size and speed. The business of these steamers is largely carrying freight, which is commonly handled by manpower and is very expensive, the loading and unloading costing as much as the transportation of a thousand miles or more. This will be contrasted later with the handling of bulk freight on Lake steamers.

Ocean-Going Cargo Steamers

Our attention has been given thus far to ships that carry passengers and which make some pretense to speed, but the great bulk of the business of transportation is by the freighter of moderate draft and displacement which can make long voyages at slow speed and enter all harbors. The "tramp" has acquired its characteristics since the United States has been practically out of the foreign freight business, it being a matter of note that a few freighters have been so far rebuilt in our country as to acquire register. These characteristics have largely been controlled by shipping laws and insurance regulations which have not always worked wisely, as, for example, in the *well-decked* steamer, which has a great *well* forward and a discontinuous deck. There has, however, been a marked improvement in recent steamers of larger capacity, especially in connection with more logical deep-frame construction, which gives at once greater strength and freer holds.

We are accustomed to think of the ship as consisting of a frame for strength and a skin to exclude the water; really the shell is the ship and the framing is to hold the shell up to its work. This framing must have longitudinal and transverse members; the latter are given unwonted proportions in the bottom so that the ship may be safely launched and docked. Until recently the skin was held in place mainly by the transverse members, which were closely spaced for that purpose. The longitudinal support for the skin by the Isherwood system allows a wider spacing of frames and a radical reduction in weight of hull. So brief a statement as this must be is necessarily inadequate and faulty, but at least emphasizes the ideas of the inventor.

Great Lakes Bulk Freighters

But if we have not entered into the freight carrying of the world we have developed a line of our own on the Great Lakes which has shown a more rapid advance and greater originality than any other development of shipbuilding. The conditions and restrictions called for a special type of ship, and having once broken away from tradition the builders have followed radical and logical lines. An enormous mass of bulk freight is handled on a draft of about 20 feet on inland waters,

mainly in the summer months. Though the voyage is about a thousand miles from Duluth to Buffalo a moderate speed of 11 or 12 statute miles per hour is chosen; if the steamer has a barge consort the speed is less. In 1897 steamers 400 feet long and carrying 4,500 tons were in service; by the end of the century the length had increased to 500 feet, and a steamer and consort could move 20,000 tons.

Built to carry a large dead load on a moderate length and small draft, with a moderate speed, the hull could have a long uniform 'midship section, though well shaped at the ends. The engines are stowed right aft; watertube boilers with a high steam pressure are used which facilitates the reduction of size and weights of the engines. To provide for rapid loading and unloading the hold is given an unbroken sweep right forward and practically the whole deck is made up of hatches. The first steamer designed for unloading directly by the grab-bucket without hand labor was the *Wolvin*. The sides of the hold in this case slope inward to trim the cargo of ore inward where the grab-bucket can reach it; massive arches span the hold. Later ships had sloping sides for somewhat more than half the depth of the hold and vertical sides, because it was found that the buckets could work into the corners conveniently. These buckets first scrape up the ore, then close on it, hoist it and transfer it to the ore pile alongside, each bucket having a capacity of 5 tons. The ship in this system becomes only a link in the chain of transportation which carries the ore from the mines in upper Michigan to the furnaces in Pennsylvania more cheaply than elsewhere in the world.

Shallow Draft Paddle-Wheel Steamers

The paddle-wheel steamer, beginning with Fulton's *Clermont,* soon developed into a characteristic type fitted for the navigation of our inland waters. The type may be considered to have come to maturity in the *Mary Powell,* which, with a speed of 17.2 knots on a length of 286 feet, was for a long time the fastest vessel. The hull, first of wood and later of steel, long and fine, was suited for speed in shallow water. The paddle guards are carried right forward and aft and faired into the sheer line of the hull. On this broad platform is built up an enormous and luxurious passenger accommodation, so that the great floating hotels, *Priscilla* and *Commonwealth,* of the Fall River Line, are licensed to carry 1,500 passengers. These magnificent steamers, which were built, one near the beginning and the other near the end of our fifteen-year period, on a length of 440 feet, can make 21 knots, so that their speed-length ratio is 1.00.

The great height of superstructure, and the fact that such steamboats navigate protected waters, allow the use of large paddle-wheels, which could properly have radial floats. Since trips were short and fuel economy of secondary importance, the simple beam engine held its own for a long time, being favored by simplicity of construction and ease of maintenance and repair. The Fall River steamers with 10,000 horsepower were given inclined engines and feathering paddles. With these improvements the steamboat is likely to remain in favor in its native country.

It is quite otherwise in the stormy channels about Great Britain, which are navigated by small high-powered steamships. In 1897 the old paddle type represented by the *Ireland* was superseded by the twin-screw steamer, like the *Ulster.* Now the service is performed mainly by turbine steamers, which do not differ in appearance from the *Ulster.*

Returning to our subject of steamboats, we find that the most recent river boats, like the *Quincy,* differ in no way from the flush times, "before the war," when Mark Twain was pilot. The paddle-wheels, located well aft, are driven by independent horizontal engines. The great headroom under the cabin deck is to receive the cargo, and a gang plank at the bow facilitates landing along the river bank.

Motor Boats

The most sensational feature of the last fifteen years is the development of extravagant speeds with small craft. At the beginning of this period steam was the propelling agent, and with it the *Turbinia,* furnished with Parsons turbines, made 32.75 knots on 100 feet, so that she had a speed-length ratio of 3.275.

After the gasoline (petrol) engine had been perfected for motor cars its application to high-speed boats was at once evident, and led to the use of the convenient, though somewhat incongruous, term "motor boat," since all boats propelled otherwise than by oars or sails may claim the name. This type of craft is well illustrated by the *Veritas,* which made a speed of 29.2 miles on a length of 54.3 feet, the equivalent speed of 25.4 knots, giving a speed-length ratio of 3.4. They are, of course, smooth-water craft, and are essentially toys, but are most interesting as showing the conditions required for extreme speed. An extreme development of this toy is the hydroplane, which skims along the surface of the water and has no proper waterline length, and consequently cannot be said to have a speed-length ratio.

Sailing Ships

It is with a certain feeling of regret that we consider the beautiful ship *Dirigo,* built of steel at Bath, the old home of the American wooden clipper ship, because it seems to close a long chapter of the history of shipbuilding. Even the wooden schooner, with its multiple number of masts, its power-hoisting gear and its pitiful tale of men, two for each mast, and two more, including captain and cook, will soon be a thing of the past. Even the phlegmatic Dutch have turned from the picturesque to the practical and are building steel barges and lee-board luggers. The six-masted schooner *George W. Wells,* carrying 5,500 tons burden, has a crew of fourteen and a 30-horsepower boiler; all hoisting and hauling is done by steam, and there is a steam steering engine, a most efficient and business-like combination. It is regrettable that such fore-and-afters are not suitable for ocean navigation, because the application of power to square riggers is not so practical, and so their day will the sooner be over.

Naval Vessels

If the last fifteen years has shown a culmination of the competition for size and speed of merchantmen, we realize that we are now in the midst of a mad race for supremacy in naval material. In that time the United States has advanced from a position of inferiority to that of one of the trio of great naval powers. At the beginning of this period the naval world had developed a definite type of warship, which indeed showed variations but not what the naturalist would call specific differences. This type reflected the condition of naval gunnery then existing, a condition shown by the battle of Santiago, in which there was 3 percent of hits, though it must be admitted that this, like the rest of the action, was a caricature of a naval action. The type can be represented by the British battleship *Majestic,* which on a displacement of 14,900 tons made 17.9 knots on trial. The length was 390 feet and the speed-length ratio 0.9, like that of an express steamer. The battery consisted of four 12-inch guns and twelve 6-inch guns. It was expected that actions might be fought at 3,000 yards, at which the 6-inch guns could destroy all but the heavy waterline belt and the big gun positions; the 12-inch guns, which were slow in fire and uncertain in hitting, were carried to give the *coup de grace.* Such an authority as Captain Mahan considered the 6-inch guns as the main battery.

The year 1897 saw the completion of our first modern seagoing battleship, the *Iowa,* which on a displacement of 11,000 tons made a trial speed of 17.1 knots, but as her length was only 360 her speed-length ratio was 0.9, which is nearly a

maximum for heavy ships. She exhibited the American abiding belief in big guns and plenty of them, for she carried four 12-inch guns and eight 8-inch guns; she carried also ten 4-inch guns on the broadside. Now the 8-inch gun is about two and one-third times as big as a 6-inch gun, and therefore, in a sense, the battery carried by the *Iowa* was equivalent to eighteen sixes. The 8-inch gun, which is after all a big gun, has been carried in the secondary battery of all our ships from that time on, except some half dozen which conformed to the British type. In these days of big guns and long range it is fortunate that our ships carry so many of them.

In 1904 Italy began mounting 8-inch guns on battleships, and in 1905 Great Britain mounted 9.2-inch guns, which though more powerful are in the same class, thus following our lead. There is good ground for difference of opinion concerning the relative advantages of big-little guns like sixes, and little-big guns like eights and nines, and the use of the latter may indicate only a desire to give an appropriate battery to ships that were continually growing in size; thus the *King Edward* has a displacement of 16,350 tons, against the 14,900 of the *Majestic,* and carries four 12-inch guns, four 9.2-inch guns and ten sixes instead of four 12-inch guns and twelve sixes.

Meanwhile two influences had been acting to bring about a radical change in battleship armaments and a great increase in size. One influence, but probably not the predominant one, was the increase of the range of the automobile torpedo to 3,000 yards, and the other, which alone would have sufficed, namely, the construction of efficient range finders. Naval artillerists of all nations were alive to the fact that the most destructive fire against ships was with heavy shells—provided they hit. Then began the marvelous development of naval marksmanship with heavy guns together with an increase in the rate of fire. In consequence the battle range has been increased to 6,000 yards or more, so that the 6-inch gun becomes quite ineffective. The effect of this change is to insure the predominance of the big gun, and nothing must be allowed to interfere with its effectiveness. This rules out even the secondary big gun like the 9.2-inch or the 10-inch guns.

In 1906 Great Britain launched and completed the *Dreadnought,* which carried ten 12-inch guns on a displacement of 17,900 tons at a speed of 21.8 knots. The length is 490 feet, so that the speed-length ratio is only 0.88. The United States, having independently studied the same question, followed with the *Michigan* and *South Carolina,* which carried eight 12-inch guns on the centerline, on 16,000 tons displacement, with a trial speed of 18.8 knots. These ships were launched in 1907 and completed in 1908. They were to some extent controlled by the habit of Congress of including both cost and size in bills authorizing construction of ships, and the true American big-gun ship is represented by the *Delaware,* completed in 1910, which carries twelve 12-inch guns on 20,000 tons displacement at 21.5 knots. The peculiar feature of these ships, which carry all guns on the middle line, so that they are equally effective on both sides, has finally been adopted by all nations for their first-class ships.

Armament of Warships

The big gun idea is not new, for the tendency of building the largest practicable gun and mounting it on all ships was clearly marked in our navy before the Civil War; that gun was the eleven-inch cast iron smooth-bore, the best naval gun then afloat, and it was chosen because it had the advantage of range and destructiveness. During the war the fifteen-inch gun was developed for the monitors to give power, much as now the desire to increase power leads artillerists to turn to fourteen-inch guns. With this history in mind the writer as early as 1902 asked a well-known naval designer, "Why not mount twelve-inch guns only?" and the answer was that the step was too great to be taken at once.

Should it once be settled what type of big gun is most effective, then the corresponding type of battleship could be worked out on the basis of the number of guns that could be worked effectively. Now the size of the gun, in the end, depends on such metallurgical operations as forging and tempering the great tubes of which such guns are built up, and of these, one at least—namely, the tempering—is a surface operation which probably has been brought to the highest efficiency. As early as the beginning of our fifteen-year period a leading steel maker told the writer that the thickness of such tubes was limited to about seven inches by such considerations, which would account for the failure of early guns of mammoth size. It is hardly wise to set a limit, for limits have a habit of moving upward and onward, but anyone can note that the fourteen-inch gun is given a less muzzle velocity than the twelve-inch gun, which means a less powder pressure. In fact, the coast-artillery, fourteen-inch gun was avowedly designed for a less pressure in order to secure longer life for the gun. But the land gun is set in azimuth and altitude like an astronomical instrument and places its shot with precision, so that flatness of trajectory has not the importance that has always been found at sea, where ranges are uncertain. Perhaps the naval artillerist begins to feel the same confidence in his range-finding, and is ready to seek for longer life of the gun and heavier bursting charges in shells. But whether the gun shall have twelve inches or fourteen inches caliber, it looks as though the question of gun and ship might be soluble if other elements are not injected.

We are sometimes inclined to think that the radical and rapid changes which characterize our times are found only in our times, and that our forefathers were slow, if not inert, not realizing that a rapid change requires two elements—first, the clear grasping of an idea, and, secondly, the ability to carry it out; it is in the latter that we have the advantage pre-eminently.

Naval Warfare

Such a change took place about the year 1665 in the wars between the English and Dutch in consequence of the formation of the close-hauled line-of-battle. Before this time warships of all sizes were built and all were drawn into the confused battles in which nations strove for mastery at sea. In the war that then broke out between these two nations of seasoned seamen both knew the advantage of the line-of-battle formation and used it so far as possible. In the Four Days' Battle, of June, 1665, the English had 80 ships and the Dutch, 100; there appears to have been much diversity of size and power of ships in both fleets, the Dutch having little advantage from numbers because in general their ships were of less size. Our interest is now not who won, nor how stubborn and bloody was the fight, but that from this war emerged the line-of-battle ship.

The type of ship was already in existence in both fleets and thereafter none but that type was built for the capital fleet. It may be characterized by the two-decker, seventy-four-gun ship, and the three-decker, hundred-gun ship, the tendency on the whole being toward the heavier ship, though it was a poorer sailer and less seaworthy. The size of the gun was limited because it must be man-handled and the ship because built of wood. So well settled was the type that Nelson's *Victory* at Trafalgar in 1805 was eighty years old.

The other type of wooden man-of-war was the single-decked frigate, which accompanied fleets and acted individually but was not placed in the line. The type was thoroughly seaworthy, and so much better a sailer than the line-of-battle ship that it could be brought to action only by ships of the same type. Of this type was the *Constitution,* a little larger, a little more heavily armed, and a little better ship

than frigates of other nations. Great Britain cut down two-deckers into frigates to meet her class.

The Tendency in Warship Design

This digression is in hopes of finding order in the present situation. In the first place nothing can be allowed to interfere with the true line-of-battle ship; its type may not yet be determined, but when the gun and speed have been settled there is likely to be permanence. Our older and slower ships will, of course, be replaced, but all armored ships carrying twelve-inch guns will surely lie in the line if occasion arises. Not so our armored cruisers like the *Maryland,* magnificent ships which might well lie in the line in her day when the six-inch gun might have decided the day; even the later cruisers with ten-inch guns are outclassed.

At the same time that Great Britain produced the *Dreadnought,* she surprised the world with an entirely new class, the battle cruiser represented by the *Indomitable;* she carries eight twelve-inch guns on 17,250 tons, and has a speed of more than 25 knots on trial; her length being 530 feet, the speed-length ratio is more than unity. The later ships of this type are to be 660 feet long, to make 28 knots, and to carry eight 13.5-inch guns. Germany only has followed in constructing ships of this class. It appears that the battleship and the battle cruiser are in fact two types of line-of-battle ships which are likely to approach as the displacement increases, and that in the end we shall have a well-defined class of large, heavily-armed, fast ships, which type may become permanent unless displaced by an entirely different type of fighting.

The question remains, what type of ship shall take the place of the frigate, the eyes of the fleet which is not expected to lie in the line? The various types of protected and armored cruisers were developed for this purpose, but have all been outclassed by the battle cruiser, as has also the scout cruiser. There is reason to think that the important duty of scouting and of protecting the battle fleet from the enemies' scouts will be performed by vessels of the type of the torpedo-boat destroyer, now really a powerful ship, which deserves a better cognomen. At the beginning of our fifteen-year period this type was well advanced, being represented by the British *Fame,* which, with a displacement of 272 tons, made 30 knots on a length of 210 feet. Our later type is represented by the *Flusser,* which has a displacement of 700 tons, and can make 33.7 knots on a length of 289 feet. The *Flusser* has steam turbines, which developed nearly 12,000 horsepower; this may be contrasted with the 5,800 horsepower of the reciprocating engines of the *Fame,* and so we may estimate the cost of the relatively small increase in speed. On the other hand, the *Fame* carries one 12-pounder and five 6-pounders, while the *Flusser* has five 13-pounders. The increase in tonnage from 272 to 700 very much increases the weatherly qualities of the vessel. It is likely that the displacement may reach 1,000 tons for ships of this class, which approaches the displacement of old-time frigates; our *Constitution* had 2,200 tons, but was a large and heavy ship of her class.

The new arrival in the field of naval warfare is the submarine, which is even considered by some as a rival to the armored battleship. In 1897 a Holland submarine, 55 feet long and propelled by a 50-horsepower gasoline (petrol) engine, was launched at Elizabethport; this was a small, low-powered boat compared with contemporary submarines built in France, where these craft were first developed in practical form. Even in 1903 the boats for our navy were small and feeble, such as the *Pike,* which is 63 feet long and has 160 horsepower when running at the surface, which gives a speed of 8½ knots. Submerged she makes only seven knots. Submarines building are reported to have 525 tons displacement, with speeds of 14 knots at the surface and 9½ immersed. Great Britain reports submarines of 800 tons displacement to have 15 knots speed, and larger boats are said to be contemplated. That such craft will greatly increase the difficulties of a blockading fleet and add to the nervous strain of the commander will be certain; they may render inclosed areas and all spaces near the land untenable for battleships on account of the discrepancy of the cost of the submarine and its natural prey, the large armored ship. This will increase the importance of the destroyer, which will be unlikely to give place to any craft which is not larger nor more expensive. The consequence is likely that important naval engagements will be in the open sea, where the advantage of large ships and big guns can be best developed.

Lessons From Recent Naval Battles

During our fifteen years there have been two naval wars, a little one of our own and a large one in the Orient. Both exhibited the fact that however costly preparation may be, lack of it is vastly more costly, and that the most wasteful course of all is to go through the form of preparation without the spirit that makes it effective. There is much to learn from the ships which went into action in these wars, but, aside from the lesson just indicated, this information relates mostly to the effect of gun-fire, which could have been learned by firing at condemned ships, as has been done both before and since these wars. The drift toward big guns only began before the more recent of these wars and has been little influenced by it.

A lesson that should be taken to heart is the futility of trying to improvise a naval force, or any part of such a force, after trouble begins. This lesson is the most important for us because the exigencies of a new country have bred the habit of getting along with inadequate means, and because we have twice had the good luck to do just what is here inveighed against. In 1861 the South had no navy and no means of building one; anything that could float a gun might serve a purpose. In 1898 the enemy was in much worse condition than ourselves.

Let us take a glance at the efforts at improvisation when last tried. The government bought two cruisers, a gunboat and two torpedo-boats; the cruisers (though different from what we should have built) are still in service, having both speed and gunpower; the other craft are happily forgotten. But, after all, buying warships at a pinch is all right; how about the non-military ships? A rough count shows that the government bought or chartered about 30 ocean steamers, 20 tugboats and 25 yachts. All the ocean-steamers were needed for transports and for other purposes and the four 20-knot Atlantic liners were invaluable; our only regret was that we had not more and better.

The tugboats and yachts were given such light guns as could be found and fitted, and were called auxiliary gunboats; against an active foe they would have been unable to fight or to run away. Our sailors handled them gallantly and, as on the *Gloucester* at Santiago, added luster to our naval fame; another time the same gallantry could be expected to yield nothing but bitter loss and shame.

Recent Aids to Navigation

Three notable aids to navigation and to safety at sea are wireless telegraphy, submarine signaling and the gyro-compass. Each should receive a whole paper for adequate description, instead of the bare mention now possible. The first appeals at once to everyone, especially as a means by which a ship in distress may call for aid. Its importance to the warship is even greater, but a disadvantage which is not commonly known to the casual reader is illustrated by the fact

that Russian cruisers habitually detected the neighborhood of Japanese vessels by picking up messages, some of which they could read and others not.

When the navigator approaches a shore in the fog he can only feel for bottom with the lead line and listen for fog signals. The first is sure but indefinite; the second can be made definite, but it is elusive. The writer was one of a party that came up toward Boston light on a fair day when the great foghorn was sounding; each blast was betrayed by a puff of steam; as we came up, the blasts could be heard distinctly, till we came slowly on the lighthouse tender to a certain limit, beyond which the sound disappeared and we could see but not hear each blast on the horn. The submarine signal struck on a submerged bell does away with this uncertainty, for the denser fluid is not affected by dead-spaces and ghosts. The navigator can pick up the sound in a special telephone receiver and can judge both the distance and direction of the bell; if he hears two bells he can triangulate for his position.

"True as the needle to the pole" is good poetry but poor navigation. The navigator's motto is "When in doubt, distrust the compass." The two evils that beset the compass on a steel ship are variation of the magnetic meridian and deviation due to the magnetic action of the steel of the ship itself. The importance of magnetic surveys is indicated by the fitting of the non-magnetic auxiliary brig *Carnegie,* built of wood fastened with bronze, and provided with copper and bronze propelling machinery. But important as magnetic surveys may be, it is not the variation that worries the navigator, because it changes regularly and slowly, but the deviation which is full of vagaries. A captain of a coast-wise steamer told the writer that lying two or three days at the dock in Baltimore developed enough temporary magnetism (if not allowed for) to throw him out of the channel on the way out. It is notorious that after target practice on a man-of-war all compasses are liable to complete derangement; after an action the most reliable compasses on bridge and superstructure would be liable to be swept away.

The gyroscope-compass, which depends on Foucault's principle, is actually true to the pole, and always points to the true astronomical North. This compass carries a swiftly rotating gyroscope or flywheel with its axis hung horizontal in gimballs. Under the influence of gravity this axis swings into the true meridian and is uninfluenced by magnetism or any other extraneous influence. Once properly adjusted it requires no other attention than to keep the machinery for spinning it in good condition. Since the compass is expensive and somewhat heavy, only one master compass is installed in a safe and convenient place below decks; repeating compasses, controlled by electric transmission, can be placed as convenient on the bridge and in the wheelhouse. These compasses will become necessities for warships and on all large and important ships.

Application of Electricity to Hull Auxiliaries

All large ships have extensive electric equipment, so much that the electric elevator (lift, on English steamers) is familiar on the Atlantic liners. Warships have electric ammunition hoists, and turret-turning machinery and elevators from the fireroom. But the anchor-gear, the steering-gear and deck winches are still worked by steam, and electric gear for such purpose are but now forcing their way into service. To provide for steam gear it has been necessary to carry a steam main right forward and aft; and this steam main is expensive, wasteful and troublesome; when below decks it is apt to be uncomfortably hot. Now the anchor engine may be brought up standing when the pull on the anchor chain exceeds a computed amount, without danger of carrying anything away; when the strain is reduced the engine starts up again; the deck winch behaves in the same way. In a word, the torque is constant. On the other hand, the tendency of the ordinary electric motor is to increase the torque as it slows down, so that early deck winches habitually broke the lines. As for the steering-gear, it must follow the wheel in the hands of the steersman, and at the same time have such elasticity of action that the rudder may yield to the blows of the sea and yet automatically return to the proper setting. The delay in the introduction of the electric gear is due in part to the peculiarities of the service and in part to the failure of electricians to appreciate them.

Ventilation

If the sea were always smooth all would be good sailors, but in bad weather the motion of the ship and lack of ventilation are liable to be simply nauseating. Now the path of the ventilating engineer, even ashore, is strewn with ambitious failures, and the difficulties of overcrowding and high winds at sea are many-fold more difficult. This explains at once the high prices demanded and paid for deck staterooms where ports may always be opened. The best success at sea is by aid of numerous separate systems which may distribute fresh air, warmed, if required, to restricted spaces. The *Olympic* has seventy-five electrically operated fans, some working under pressure and others exhausting foul air.

Anti-Rolling Devices

In a general way the big ship is less easily thrown about by the sea, and that is one reason for the favor in which it is held; but the largest ship must yield especially to waves that have the right period. Now the ship has two motions, pitching and rolling. As for pitching, the mind of man has devised no remedy; the passengers may draw as far as possible toward the middle of the ship and then they may even take what comes. But rolling may be largely controlled by making the natural swing of the ship slow and gentle. Contrary to a natural idea, it is the tender ship rather than the stiff ship that is steady. Bilge keels also help to check the rolling, though they add to the power demanded of the engines. Small ships, like channel steamers, cannot be made tender enough to check rolling without undue danger, and for them Schlick's application of the gyroscope on a relatively large scale has been found efficacious, especially in reducing the regular rolling due to waves which have the same period as the ship. The recent big battleship, with its enormous battery carried over the decks, also must have considerable stability, and is liable to be a quicker roller than some of the older types. The proposition to apply gyroscopes to them brings in special engineering difficulties because they involve considerable weights, high speed and heavy-bearing pressure. An alternative proposition is the use of quieting tanks, as once used in a cruder form on the old central battery armored ships. Two tanks are installed, one on the port side and the other on the starboard, with communicating passages nicely adjusted, so that as the ship rolls the water shall always be found on the down side ready to resist the heave of the ship. The application of such devices is likely to be limited because the steadiness and comfort of large ocean passenger ships are now very satisfactory.

Two Russian cruisers, each 266 feet 8 inches long by 42 feet 2 inches beam, of about 3,500 tons net and 1,200 horsepower, have been fitted with Diesel engines by one of the leading marine engine builders in that country. This firm has also furnished Diesel engines for five 1,000-horsepower gunboats, one 900-horsepower gunboat, one 750-horsepower government inspection ship, together with other craft, which brings the total up to 90 ships aggregating 20,000 horsepower.

Progress in Marine Engineering During the Past Fifteen Years

BY DR. W. F. DURAND

The past fifteen years has witnessed in all branches of engineering and industrial art a development and progress probably unparalleled in the same period of time hitherto. In no branch is this perhaps more true than in marine engineering, and in the present article an effort will be made to note and evaluate the more important items and features which have, during this period, characterized the progress in this particular field.

Fuel

Coal has remained throughout the period the dominant fuel in the marine field, though there has been a significant and progressive increase in the use of liquid fuel, either crude petroleum or residues after partial distillation. The possibilities of oil fuel in the field of marine engineering began to attract the attention of engineers during the decade from 1880 to 1890 and in the Congress of Engineers, held at Chicago in 1893, an important paper was read by Colonel N. Soliani, of the Royal Italian Navy, setting forth the practice at that time and the results of experience in which the Italians had taken the lead. Further experience was gradually accumulated and the use of oil extended slowly, until, in the later years of the decade 1890-1900, the principles governing the effective use of oil as a fuel had become fairly well established and further and more rapid extension in its use became dependent on economic conditions of cost and availability rather than upon the engineering problem of its efficient use. Since those years and down to the present time progress has been along the same lines. Further study has added to our understanding of the conditions necessary for the efficient combustion of oil fuel as an engineering problem, and at the present time this phase of the question may be said to have reduced itself purely to one of minor mechanical detail. At the same time the discovery of new oil fields, increase in production, improved methods of handling, transportation and storage: these, combined with the economic possibility of placing it on board a steamer at a price which will compete satisfactorily with coal viewed simply as a means of producing steam; these various facts have all combined to widen in marked degree the progressive use of oil as a marine fuel.

At the present time the United States navy stands committed to the definite use of oil as a fuel for both battleship and torpedo-boat types; several lines of steamers plying on the Pacific and elsewhere are committed to its use either exclusively or in large part, while it forms naturally the fuel used by the large and ever-increasing fleet of steamers engaged in the oil trade itself.

A typical present specification for oil fuel is as follows:

Gravity, degrees Baumé	15 to 18
Weight per barrel of 42 gallons	336 pounds
British thermal units per pound	18,500
Moisture, not to exceed	2 percent
Sulphur, not to exceed	5 percent
Flash point, degrees Fah., not below	200

The principles and methods of fuel oil combustion have received such full attention in the engineering press that in the present article there is no occasion for more than such brief mention as will serve to mark out the chief lines of progress during the past fifteen years.

Speaking broadly the general conditions for the efficient combustion of oil fuel are as follows:

(1) The introduction of the fuel into the furnace as a vapor or in such a finely divided spray that its passage into the condition of vapor will be practically instantaneous.

(2) The intimate mingling of the vapor thus formed with air sufficient for complete combustion.

(3) The production of this mixed vapor and air at the highest practicable temperature previous to ignition in order that the minimum heat may be taken from the furnace for the elevation of such mixture to the point of ignition.

(4) Suitable dimensions and volume of the furnace in order that the combustion may be practically completed before the gases enter in or among the tubes.

The following general features are characteristic of the best present practice with oil fuel, the relation of which to the general principles above noted will be, for the most part, plainly apparent.

(1) Settling tanks to allow water and sand to settle out, so far as the gravity may permit, before going to burners. Present specifications for fuel oil usually fix the water content at not exceeding 2 percent, and in such cases gravity settling will effect little further. If drawn from near the bottom of storage tanks, however, or in case double bottoms are used for extra or reserve storage, water in greater proportion may be present and settling tanks are requisite. They are preferably fitted in duplicate so that one tank may be settling while the other is furnishing the oil for current demand.

(2) Means of heating the oil to insure fluidity at the burners, to facilitate the transformation of oil spray into vapor and to furnish such vapor at the highest practicable temperature, independent of direct demand on furnace heat. Such heating is usually furnished by exhaust steam coming from the pumps mentioned in (3). The permissible temperature of the oil depends on the gravity and flash point. With standard grades with moderately high flash point the temperature may safely approach 200 degrees Fahrenheit. Temperatures too high tend to develop a deposit of carbon on the oil-heating surfaces.

(3) Oil service pumps for handling the oil from storage to tanks and thence to the burners. The delivery line to burners should be fitted with strainers in duplicate so that all solid matter may be removed and the danger of clogging the burners may be minimized. With such strainers in duplicate with appropriate shut-off valves, either may be cut out and cleaned while the other is in service.

(4) Means for atomizing the oil and introducing it into the furnace with sufficient air for combustion. For effecting atomization three means have been employed—steam, compressed air and mechanical means.

Steam atomization involves the waste of fresh water by way of the smokestack, and this constitutes a heavy drain on the make-up feed supply. For this reason steam atomization is commonly restricted to inland waters or to short trips. The steam pressures employed range commonly from 60 to 80 pounds, combined with somewhat similar or slightly lower pressures on the oil line.

Air for atomization is applied at pressures all the way from one pound to 60 or 80 pounds, according to the system employed, combined with suitable pressures on the oil line.

With mechanical means of atomization the oil pressure maintained must be adapted to the characteristics of the system.

(5) Furnace arrangements, including means for admitting

the right amount of air, distributed in accordance with the needs for complete combustion, and also such dimensions and proportions of furnace and such distribution of fire brick for radiation purposes as shall insure completed combustion before the flames come into direct contact with the heating surfaces of the boiler.

With Scotch boilers the furnaces are usually too small for best results. This boiler as a type has been developed with special reference to coal fuel. To realize the best results, the entire boiler design should be developed with reference to oil fuel. With watertube boilers desirable furnace volumes and proportions are more readily realized than with boilers of the Scotch or internally fired type.

The chief advantages which may properly be claimed for oil fuel are as follows:

Labor is saved in the fire-room; the coal passer is practically eliminated; the thermal efficiency of a boiler with oil fuel is higher than with coal, and in consequence of this and of the higher heat value per pound the evaporation of steam per pound of fuel is greater for oil than for coal in the ratio of about 10:7; oil per ton occupies less space than coal in the ratio of about 9:11; oil is cleaner than coal as regards the absence of ashes and of dust in fueling ship; under proper conditions of use the cost of maintenance of boilers with oil fuel is less than with coal; oil can be handled mechanically, and with proper facilities more expeditiously than coal, thus saving time in fueling ship; oil stows more readily than coal, and otherwise unavailable spaces may be used for oil tanks, and it may be carried in double bottoms if necessary.

The chief disadvantages which have been urged aside from the question of economic price may be summed under the heads: noise, odor, danger. All three are under definite and satisfactory control. The latter, which is the only one of importance, calls for intelligent use in the furnaces, for suitable provision regarding means for ventilation of oil tanks, and for specially good riveting on all joints which are intended to be oil-tight.

Extended test and experience show that economically 1 pound of good fuel oil with a boiler economy of about .75 will evaporate under average actual conditions about 13 pounds of steam. This will correspond with good engines to a horse-power-hour for from 1 to 1.25 pounds of oil. It will readily appear from these figures, compared with the corresponding values for coal fuel, that having in view fuel costs alone, the two fuels will represent equal steam-producing value when the cost of coal per ton of 2,000 pounds is about 4.1 times that of oil per barrel of 336 pounds. With a relative cost near this value or slightly higher, there will be undoubted over-all economy in the use of oil fuel.

The use of a certain percentage of the steam or its equivalent energy in compressed air for purposes of atomization has stood from the first as a heavy tax on the economic results available with oil fuel. The amount is rarely less than 3 to 4 percent, or about ½ pound of steam per pound of oil. This means the reduction of a gross evaporative efficiency of, say, 75 percent down to 72 or lower. In the past few years increasing attention has been given to the development of mechanical forms of atomization, some of which have shown results corresponding to a steam consumption not exceeding 1 percent of the boiler output. The possibilities of this form of atomization represent perhaps the most significant feature in the present trend of progress, and should receive the careful attention of engineers who are contemplating the use of oil fuel.

Boilers

During the decade 1890 to 1900 the watertube boiler made continuous and increasing gains in the field of marine engineering, a field which it had definitely begun to share with the older fire-tube types during the preceding decade. By the close of the century it had acquired practically complete possession of the field of small craft, and in particular where saving of weight and high speed were distinguishing features. In the field of naval design this included the launch and torpedo boat, and in some few instances watertube boilers of the Belleville form were installed in ships of the cruiser type and also in certain vessels in the merchant marine. The older Scotch form of fire-tube internally-fired boiler remained as the dominant, or practically the only type throughout the remainder of the field, including with few exceptions all naval vessels of the cruiser and battleship class, and the wide field of mercantile steamers of all sizes and types from the ocean greyhound to the humble tramp.

During the period which has elapsed since those years the chief field of change has been that of naval design. At the present time, the world over, warships of all types and sizes are fitted, almost without exception, with boilers of the watertube type, while in the wide field of the mercantile marine the Scotch boiler still remains dominant, although even here the watertube boiler has made some notable gains.

The distinguishing features which have determined this steady growth in favor, especially in the field of naval design, are (1) saving of weight due to decreased amount of water in boiler; (2) greater capacity for forcing, especially in the so-called express or small tube forms; (3) greater flexibility in service, permitting rapid raising of steam, or, in general, rapid variation in rate of output as required by rapidly varying conditions; (4) relative safety from results disastrous to the ship in case of explosion.

Certain of these characteristics have at the same time necessarily entailed consequences which have operated to retard a correspondingly rapid extension of favor in the mercantile marine. These are (1) the reduced amount of water, requiring much closer attention to the feed and greater sensitiveness to variations in regimen, or, in general, to the conditions of service; (2) greater cost of upkeep than for fire-tube boilers, more particularly in certain of the earlier types where the features of design were less perfectly adapted to the conditions of service than in the later forms; (3) the demand in general for a higher grade of intelligence for their efficient management and care than in the case of fire-tube boilers. This argument has become gradually of decreasing importance, due to a continuously growing familiarity with such boilers among firemen and water tenders in general, and due to improvements in design and in fittings which have aided in bringing such boilers under more definite and reliable control.

Watertube boilers have been classified according to all varieties of characteristics. Thus we have had boilers with straight tubes and with curved or bent tubes; boilers with continuous or unbroken elements and with elements made up of screwed joint connections to drums or headers; boilers with outside down-flow and with inside down-flow; boilers with large tubes and with small tubes; boilers with tubes nearly horizontal or nearly vertical or at some other more or less definite angle; boilers with the upper ends of steam forming tubes flooded and boilers with such tubes dry; that is, discharging their contents of mixed steam and water above the water level. In addition, the combinations of tubes with drums or drums and headers have been worked out with a most bewildering variety of geometrical form and mechanical connection. Out of this variety of form, which perhaps was at its height in the early years of the period under consideration, have come a few fairly well defined types or forms which have demonstrated general superiority and efficiency for the particular class of service in which they are employed.

Thus in the field of the small fast steam launch, fast steam yacht, torpedo boat and destroyer types, and in general wherever the combination of minimum weight of machinery and maximum speed are distinguishing features, the accepted

and standard form of watertube boiler is represented by the small tube or express type. Boilers of this type, represented by the Thornycroft, Yarrow, Normand and Mosher forms, include some combination of upper or steam drum with lower or feeder drums through bundles of steam-forming tubes, usually from 1 inch to 1½ inches in diameter and straight or curved according to the characteristics of design. Such boilers according to the degree of forcing will furnish from 8 to 10 or 12 pounds of steam per square foot of heating surface, and will weigh with water about 1 ton per 60 to 100 indicated horsepower developed with good triple-expansion engines. Such boilers commonly carry steam pressures from 250 to 300 pounds, and are provided with steam drying or steam superheating coils or pipes in varying degrees. On the other hand, for naval ship or cruiser and battleship types, and in the mercantile marine where watertube boilers are employed, practice is divided between the small tube type as above and the large straight tube type, of which the marine Babcock & Wilcox form is perhaps the most widely used and most typical of present-day practice in this field.

The tubes in such boilers are from 2 to 4 inches in diameter, and are connected by means of headers or manifolds to a suitable upper or steam and water drum. Such boilers under moderate forcing, such as is intended for normal service in this field, will evaporate from 5 to 8 pounds of steam per square foot of heating surface, and with water will weigh 1 ton per 25 to 40 indicated horsepower developed with good triple-expansion engines. Such boilers carry steam pressures from 200 to 250 pounds, and are occasionally associated with superheater elements or specially fired superheaters for drying or superheating the steam to a point depending on the character of the prime mover, whether reciprocating engine or turbine.

There has been an insistent demand throughout the period under consideration for improvements in economy in all branches of engineering. Conservation of natural resources, scientific management and other allied movements are all expressions of the same fundamental demand. In the field of marine engineering these considerations have exercised a profound and determining influence, and it is not too much to say that the chief progress in connection with the steam boiler during the past fifteen years has been in connection with considerations bearing on the general problem of operative economy. The marine boiler in general necessarily suffers somewhat in this respect in comparison with the typical stationary power plant boiler. This is due to two primary causes: (1) The marine boiler must of necessity be worked at a rate of output per square foot of heating surface from two to four times that of the stationary boiler; (2) the setting can rarely be made as effective against radiation losses in the case of marine as compared with stationary boilers. Both of these limitations trace back to the marine requirements of weight saving, and due to their influence it can hardly be expected that a sustained boiler efficiency, even on large ships and where the conditions are only moderately severe, can much exceed 75 percent, while under severe forced conditions, as on vessels of the torpedo boat or destroyer types, the value will naturally fall considerably lower. These values are 5 to 10 percent lower than those attainable in stationary practice, and this handicap the marine designer must, as a rule, accept as a consequence of the controlling conditions of his problem.

The conditions for the highest boiler economy are in brief: (1) To maintain continuously the conditions for complete and perfect combustion; (2) to supply the minimum weight of air per pound of fuel consistent with (1); (3) to deliver the resultant furnace gases to the stack at the lowest possible temperature; (4) to reduce to the lowest possible minimum all radiation and like secondary losses. Requirement (3) in particular is inconsistent with forced conditions or a high rate of output per square foot of heating surface. Much, however, has been accomplished along these various lines. In order to satisfy condition (1) the introduction of the fuel and air into the furnace should be continuous and regular. This is a distinguishing feature connected with the use of oil fuel, and is in no small degree accountable for the increase in efficiency with oil as compared with coal. Much, however, can be accomplished by light, frequent systematic firing, and the system of "clock-work" firing which has been introduced into the naval service shows what may be done by way of improvement over the older "hit-and-miss" method. The excess supply of air is usually estimated by means of some of the many forms of CO_2 indicators or recorders. These are not in as common use in the marine as in the stationary fire-room, but they are attracting favorable attention, and point the way toward at least one method of securing better control over the irregular variations to which the air supply is commonly subject. The use of feed heater elements and the more intelligent distribution of baffles for securing effective distribution of the gases in the case of watertube boilers are all working toward a lower ultimate stack temperature, and toward saving at this important point of heat loss.

In this general connection reference may be made to the astonishing results which have resulted in the naval service from the introduction of the competitive idea, combined with the intelligent appreciation of these fundamental principles of economy. Savings in the most marked degree have been realized by the simple combination of brains with the resources of the engineering world. Results such as have been thus accomplished show plainly the possibilities of improvement, and mark the pathway along which further effort should be made.

Notable progress has also been made in the further study and better understanding of the conditions affecting general upkeep, especially those related to chemical corrosion and to scale formation. In particular, the status of fresh water as the only acceptable feed for marine boilers, no matter what the type, has been established, and the evaporator or some equivalent make-up provision for feed water has become a definitely accepted feature of marine design.

Superheating coils or other equivalent means of superheating the steam have become an accepted feature of marine design where turbines are involved. There has been, however, no great advance in the use of superheated steam otherwise.

Recent lines of development in connection with the marine boiler have thus centered about the following points: Minor improvements in detail and in connection with the conditions of operation of the Scotch boiler; try out and elimination among the various types of watertube boilers; special study of the conditions affecting economic performance and cost of upkeep in the marine fireroom in general.

Whatever the lines of development in the near future, it is sure that the latter will constitute a continuing subject for careful study and that not the least contribution of the past fifteen years in this field of engineering practice will be the definite recognition of the high importance of such considerations and the good start which has been made in bringing them under definite engineering control.

The Reciprocating Steam Engine

Fifteen years ago the reciprocating steam engine was practically undisturbed in its possession of the field of marine engineering. The marine steam turbine had barely appeared above the horizon in the performance of the *Turbinia*, the gasoline (petrol), naphtha and alco-vapor engines were attracting attention for launches and similar small craft, and storage battery electric propulsion had shown some hopeful possibilities for moderate speeds and under special conditions of operation. With these unimportant exceptions the reciprocating engine was the only form of prime mover which could

have received serious consideration at this period. At the present time, while it still remains dominant in the field, nevertheless the steam turbine and various types of internal-combustion engines have made such progress in demonstrating their adaptability to the demands of marine propulsion that it requires no serious stretch of the imagination to forecast the possibility of its decline and possible disappearance in a not far distant future.

The reciprocating engine representing in effect the results of two centuries of development as a prime mover and of almost one century in the field of marine practice had attained at the beginning of the period under present examination to a finished and indeed almost final stage of development, at least as far as its main characteristics were concerned. Such engines were available in units of any size from one horsepower to ten thousand horsepower and upwards, prevailing piston speeds varied from 300 or 400 to 1,000 feet per minute, and revolutions per minute from 20 or 30 for paddle-wheel engines up through 60 to 100 for large screw-propeller engines to 400 and more for torpedo craft, and, in some cases, to 800 or 900 for special racing-craft designs. The problems which were challenging the attention of the marine designer at the beginning of this period related largely to the question of the number of stages for expansion, whether triple or quadruple, and to the number and distribution of the cranks with reference to balance and to the general problem of engine balance and ship vibration, which had been forced into prominence by the rapidly increasing demands for speed and the correspondingly increased amount of power per ton of ship structure. These are problems that seem to have been satisfactorily solved.

The lines of development during the fifteen-year period since have been concerned chiefly with the further study of the fundamental problem of balance and vibration, and with the more perfect adaptation of the engine to the demands for size or for power in relation to weight, which have continuously increased throughout the period. The problem of balance and vibration has been brought well into hand. The causes of ship vibration are well understood in their genesis and the various ways and means available for balancing the periodic inertia forces of the moving parts are well understood by marine designers. Within reason the problem of engine balance as a factor in ship vibration may be considered as having reached a final solution, and this achievement must be counted as one of the important contributions of this period to the science of marine engineering.

There have been also ever insistent demands for units of larger size, for less weight per unit of power developed, for greater reliability of lubrication, and in general for such a readjustment of the relation between the conditions of operation and the characteristics of design as shall secure a continuously rising economic result. There has been an answering and effective effort on the part of designers, and definite progress has been made toward improved overall reliability and economy.

The marine reciprocating engine of the present day may perhaps claim to be a finished engineering product so far as it presents a particular solution to the problem of marine propulsion. It is not implied that it presents necessarily the best solution, but, taking the solution which it does present, and viewing the demands of the problem, the conditions of operation and the present resources of the engineering field, the marine engine as a type may claim to represent as nearly a finished engineering product as human effort may presumably hope to achieve. This means that within this type only such improvements will presumably become possible as may be permitted by further advance in the physical and engineering qualities of the materials of construction which will reduce the weight of the engine and enable it to take care of higher temperatures.

The Steam Turbine

Complete and as nearly final as is the reciprocating steam engine within the limitations of its own type of design, there are at least four points of fundamental importance regarding which the steam turbine, by reason of its different design, is able to offer superior advantages. These are (1) saving in weight; (2) saving in space occupied; (3) entire absence of reciprocating parts and, hence, of vibration-producing forces so far as the prime mover itself is concerned, and (4) lower center of gravity. Among secondary advantages may be mentioned absence of internal lubrication and consequent freedom of feed water from oil, indifference to conditions liable to produce racing, indifference to priming of boilers so far as safety is concerned, and high overload capacity provided the boilers can supply the necessary steam. These various advantages are not, however, purchased except at the cost of some limitations and disadvantages. The more important of these are (1) the impossibility of realizing a reversing turbine except through the provision of a special reversing section, thus making in effect two turbines, one for going ahead and one for backing, either of which must necessarily be inoperative while the other is in use. This condition has resulted in the provision, as a rule, of less power for backing than for going ahead, a condition which limits somewhat the elements of control and maneuver; (2) the high shaft speed which is necessitated by the turbine design and the consequent difficulty in realizing the best proportions of the propeller for efficiency, and resulting in a definite loss of propulsive efficiency; (3) the fact that the efficiency of a steam turbine is closely connected with the speed and necessarily falls off seriously at reduced speeds. This feature becomes of serious importance in naval design where widely varying speeds must be counted as one of the normal conditions of operation; (4) the fact that the economy of the turbine is more dependent on size than with the reciprocating engine, and the consequent poor showing in economy for turbines in small sizes and for small craft.

In order to avoid the losses which arise, due to the high good efficiency speed for the turbine, and the much lower good efficiency speed of the propeller, certain forms of reduction gear have been employed between the turbine and propller shaft, in particular the Parsons reduction gear, which has been tried out on the steamer *Vespasian,* and the Melville-Macalpine gear, which has been installed on a United States collier. These are special forms of spur gear reductions, the use of which will allow the turbine to run at a high speed and the propeller at a much lower speed, thus placing each in the range of speed suited to its best efficiency. The mechanical efficiency of the Melville-Macalpine gear has been shown to be very high, not far from 98 percent, and with the improvement in the efficiencies of both the propeller and the turbine the result should show a definite improvement in overall propulsive efficiency. Further tests will show to what extent such forms of reduction gear are likely to form a permanent feature of turbine drive installations.

At the present time the turbine has achieved a genuine success with high-powered steamers of the ocean greyhound or fast passenger type. It has not met with equal favor for freight steamers, especially in the vast field of the moderate size, moderate speed type. It has met with success and favor for river steamers or other like craft of relatively shallow draft and high speed. It has met with favor in the field of the large fast yacht, but not similarly for small yachts and pleasure craft. It has been given extended trial for naval service by all the leading naval powers, and with somewhat divergent results. It has been used in torpedo boats, destroyers, torpedo gunboats, scouts, cruisers, armored cruisers, battleships and battle cruisers. While its limitations have been recognized, the general trend of practice during the past ten years has shown a marked increase in the use of the turbine.

In the United States navy, however, the most recent battleship designs show a departure from this trend and a return to the reciprocating engine. Experience of the most valuable character has been gathered as the result of the competitive trials and service of the three scout cruisers *Birmingham, Chester* and *Salem,* and of the two battleships *North Dakota* and *Delaware.* Limitations of space prevent any reference to the results in detail, but they have been widely published in the engineering press and show in effect, at least in these instances, that (1) the turbine has a very limited range of speed for good economy and that over a wide range of speed the economy of the reciprocating engine is superior; (2) the turbine seems more difficult, under the conditions of naval service, to keep in a state of readiness for operation, the cost of upkeep is higher and in many ways its adaptation to certain conditions of the service is distinctly inferior to that of the reciprocating engine. For these reasons in chief, the United States naval designs have returned to the reciprocating engine in the latest battleship designs. Further experience alone can determine whether this reversion is anything more than temporary.

The characteristics of a modern turbine installation are, briefly, as follows:

(1) Boilers giving either saturated or superheated steam according to choice with the particular turbine. Marine turbines of the Parsons type do not as a rule use superheated steam. Turbines of the Curtis and allied types, where the steam passes through expanding nozzles before entering the blading, commonly use steam superheated in some degree.

(2) The turbine itself. The types used in the United States are of either the Curtis or Parsons-Westinghouse types. In England, the Parsons is the favorite type; and in Continental Europe, Parsons, Zoelly and Rateau types are used.

(3) The condenser and air pump. The turbine has been found to be especially responsive to improvement in the vacuum. Whereas with the reciprocating engine the gain in economy for a vacuum beyond about 26 inches has been found to be small and of questionable amount compared with the expenditure required to realize such value, the same is by no means true with the turbine, and distinct gains are realized up to 29 inches or to the highest values which are practicable. The condenser and air pump equipments for a turbine installation are therefore much more important relatively than for a reciprocating engine. A very considerable increase in the cooling surface in the condenser must be provided, and a greatly increased capacity in the air pump. Due to these facts the typical turbine installation will occupy nearly as much floor area as the reciprocating engine, though some space vertically may possibly be saved, especially in warships, where every odd corner and pocket may have its value.

On the whole, the progress of the steam turbine as a marine prime mover has not perhaps been quite as rapid, and its acceptance has not been as general as might have been expected from its early promise. Even in the field where it has achieved its greatest success, that of the ocean greyhound, as evidenced in the *Lusitania, Mauretania* and others, the reciprocating engine still retains a strong hold on the practice of the day. The ultimate solution of the problem of the marine prime mover is perhaps not yet in sight. We are now in a period of transition or of elimination, and as a result of the movements and tendencies which are now going on we may well look for some more definite determination, at least as between the reciprocating engine and the turbine, as to the particular types of service for which one form or the other is best adapted.

TURBO-ENGINE DRIVE

As a form of compromise, or as an attempt to realize the good points of each type of prime mover, designs have been developed especially for warships and carried out in several instances, involving the combined use of both the reciprocating engine and the turbine. Such designs have sometimes included three shafts, the two outer or wing shafts driven by turbine and the center shaft by reciprocating engines. When going at moderate speed the engine alone is used, the other propellers revolving freely with their shafts and connected turbine rotors. When going full speed all three are used, and under an intermediate condition the turbines might be used alone with the center propeller shaft disconnected from the engine and revolving. In other cases both turbine and engines have been installed on the same shaft, the former turning freely when the latter only are used. In other cases, as with the *Olympic* and *Titanic,* the two wing shafts are driven by engines exhausting at about 9 pounds absolute into a low-pressure turbine driving the center shaft.

In still others four shafts are used or proposed, the outer or wing shafts for reciprocating engines and the inner for low-pressure turbines using steam from the engines.

It is a fundamental fact that the reciprocating engine is the better adapted to realize full benefit and economy from high steam pressures, and in general from the upper part of the total expansion range of steam, while the turbine in peculiar manner is suited to realize the best results from a diminished back pressure and in general from the lower part of the range of steam expansion. It is this fact, coupled with the divergent relations of the two forms of prime movers to speed variation, that have led to the effort to find the best over-all result in some combination of the two. The results in many cases of such mixed installations have been reported as highly satisfactory. Further experience will be required to determine the exact types of combination best suited to the various demands, or whether such combinations are more than a passing phase in the trial of elimination among the various forms of prime mover which are now presented for the consideration of the marine engineer.

ELECTRIC PROPULSION OR ELECTRIC DRIVE

Electric propulsion may be viewed either as a means of directly applying electric energy drawn from a storage battery or other suitable source to the propulsion of a ship, or as a form of drive intermediate between a steam prime mover (such as a turbine) and the propeller shaft.

Electric motor boats driven by energy from storage batteries were a feature of the Chicago Exposition in 1893, but the development along this line has been rather sharply limited, due to weight and other characteristics inherent in present forms of storage batteries. This particular form of drive has, however, received a notable and important application in the operation of submarines. This form of power application, introduced near the close of the last century, has received close study and important development during the past decade, so that to-day it stands as the typical form of power drive for submarine boats when navigating under water. A typical installation includes gas or oil engines, storage batteries and an electric unit which may at will be used as generator for charging the batteries or as motor to transform the energy so stored into propulsive form. While navigating on the surface or when the exhaust from the engine can be rejected to the air, the internal-combustion motor is used, a part of the power so developed being employed to operate the electric unit as a generator, and thus to charge the batteries if necessary. Otherwise, disconnecting clutches provide, while the boat is at rest or at anchor, for operating the engines for the same purpose. When the boat is navigating below the surface the engines are disconnected, and the energy is drawn from the batteries and transformed by the electric unit acting as a motor into propulsive work.

This scheme of submarine drive, which has reached a state of high efficiency, represents in all its present essential details

of growth and perfection an engineering product of the period under present review.

Turning to the other aspect of an electric drive, we may at the start note that the utilization of the combination of electric generators and motors between a steam prime mover and the propeller shaft is most consistently viewed as a means of speed reduction or, in general, of speed change. While for many years suggestions and plans have been brought forward more or less vaguely regarding the utilization of such a type of drive, it was reserved distinctly to the period covered by the present review, and to the last few years of that period, to bring such drive into practical form. The development of such a form of electrical drive may be viewed as the direct result of an effort to meet the limitations of the turbine with reference to reduced propulsive efficiency at the initially high speeds and loss of economy in the turbine at reduced speeds. These points have already been noted in connection with the turbine. The answer which the electrical drive offers is to interpose between the steam turbine prime mover and the shaft an electric generator-motor combination as a speed reduction device. This provides in the first place for a moderate and efficient speed for the propeller shaft at full speed, or in general for such speed of shaft as the propulsive conditions may demand for the best combination result. Next, by providing a step-speed induction motor with speeds, for example 60 and 100 percent of full speed, and by the use of resistance for reversing and of direct speed change in the turbine over the step intervals, a combination is achieved which allows the prime mover to run nearly uniformly at its normal high speed with moderate speed changes for maneuvering, and for motor speeds intermediate between those normally given by the pole number combinations. The motors may be stopped, reversed and started independently of each other and while the generator is running.

Such a general plan has been proposed for battleship drive, and a similar but somewhat simpler installation is at present being installed in the United States collier *Jupiter*, now building at Mare Island, Cal. The steam consumption expected from the proposed battleship installation ranges from 11.3 to 13.4 pounds per shaft horsepower-hour over a range of speed from 21 to 12 knots, while for the collier installation from 10 to 14 knots speed the water rate should range from 15.55 to 12.15 pounds. If these figures are realized even approximately, they will mark an advance over the economy to be expected from a reciprocating engine installation over the same range and under the same general operating conditions, and in still higher degree over that to be expected from a direct-connected turbine installation covering the same range of speed variation.

The Internal Combustion Engine

The internal combustion engine with gasoline (petrol) as fuel had become, by the latter part of the decade 1890-1900, an accepted feature of marine design for launches and small pleasure craft. Since that period it has grown continuously in importance and scope of service and has in fact served as the foundation for an entirely new type of pleasure craft, the high-powered racing motor boat. Parallel with this growth of the gasoline (petrol) motor, the producer gas equipment and motors of the Diesel engine type have demonstrated fitness for service in the marine field generally and are now sharing with the gasoline (petrol) type the serious attention of marine designers for many purposes for which fifteen years ago the steam engine would unquestionably have been employed.

Fifteen years ago the typical gasoline (petrol) motor boat engine was of the two-cycle type, with either one, two or three cylinders, running at three to four hundred revolutions, rarely exceeding four or five horsepower per cylinder and weighing 100 pounds and upward per horsepower. At the present time such engines for marine service are made in both the two and four-cycle types, and with cylinders from one to six or eight for a shaft and developing all the way up to 50 or 75 horsepower per cylinder, running at revolutions from two hundred or less to twelve hundred or more, and weighing down to 8 or 10 pounds per horsepower developed. For convenience of classification such motors are often classed as low speed or heavy duty, medium and high speed, although those classes shade insensibly one into another.

Installations of the low-speed class are by far the most numerous and include the wide field of moderate and low-speed launches, hunting boats, houseboats and pleasure craft in general, with a distinctly significant commercial field in fishing boats and in small river and harbor craft for various commercial purposes. The medium speed or semi-speed installations include more pretentious pleasure craft, small and moderate-sized yachts, passenger and mail boats and similar craft. The high-speed installations belong primarily to the pleasure craft field and represent the utmost that can be accomplished for power on a given weight, all with reference to the highest attainable speeds.

The type of design called for in the low-speed, heavy-duty class is such as will insure the maximum of simplicity and reliability of operation over long periods of time, with relatively cheap and perhaps indifferent quality of fuel, and with such supervision and care as relatively unskilled persons may be able to render. The upkeep in general must also be kept as low as possible, and economy of fuel such as it may be is always a requisite. This will call for conservative design with reference to dimensions and weights, and for the utmost simplicity in construction, combined with assurance of reliability and general acceptable features otherwise. The weight of such designs will usually run from 50 to 80 pounds per horsepower, and the piston speeds from 400 to 700 feet per minute.

In such class of construction for small pleasure launches, skiffs, tenders, etc., for which the power rarely exceeds 12 to 15 horsepower and the periods of continuous operation are always short, and for which fuel economy is often of less importance than first cost, the engines are commonly of the two-cycle type. In larger sizes and for more continuous and harder service, and where fuel economy becomes a matter of larger importance, the four-cycle engine has in recent years compelled acceptance by reason of its superior adaptation to such requirements. Various modifications of the two-cycle type have been tried, looking toward the improvement of the economy by the use of auxiliary cylinders for compression, special scavenging devices, etc., but without notable change in the relative status of the two types. If the two-cycle type is to be improved by further complication of parts it is doubtful if there is any good reason for stopping short of the full four-cycle type of design.

Regarding the number of cranks or cylinders with regard to evenness of crank effort, it may be noted that for the two-cycle type the single-crank engine is occasionally met with in small sizes. The two-cylinder or two-crank engine is, however, much more even in its application of power and is always to be preferred. In still greater degree the four-cycle engine in the single-crank form is unsatisfactory and is never met with in typical modern practice. The two-cylinder four-cycle is equivalent in turning effort to the single-cylinder two-cycle, and still leaves much to be desired in this respect. Three and four cylinders are better, but the standard of smoothness in effort is found in the six-cylinder, four-cycle type, with three sets of cranks at 120 degrees, and in engines of sufficient size to make the four-cycle type of significance this is the desirable crank arrangement.

In the semi-speed or intermediate type there is a higher demand per pound of material, piston speeds are higher and there must be a more exacting and careful design throughout.

At the same time the demands for reliability of operation, expense of maintenance and economy of fuel are substantially the same as in the less exacting type. Weights per horsepower in this class may range from 30 to 40 pounds and piston speeds 600 to 800 feet per minute.

While both the two-cycle and four-cycle types of engine are found in this class of design, the latter seems on the whole to be the more commonly used type, especially in powers above 25 or 30 horsepower.

In the high-speed or racing type everything is sacrificed to the development of the highest power on a given weight. This means the most refined design, reduced factors of safety, the use of materials having the highest possible physical properties as regards strength, resilience, etc., the highest practicable piston speed, and, in general, such combination of factors as will insure for a few hours' time the realization of the maximum possible power out of a given weight of constructive material. Considerations of fuel economy or of the grade and cost of fuel become thus of secondary importance. Reliability for long runs and under varying conditions may also be yielded, as well as relative simplicity and adaptability to unskilled attendance. The piston speeds realized in such engines will range from 900 or 1,000 feet up to 1,300 feet in extreme cases, and the weights will range from 7 or 8 pounds per horsepower for large engines up to 12 or 14 for smaller powers.

The fuel economy of engines of these various types and grades of construction may vary from perhaps .9 to 1 pint of gasoline (petrol). The economy of high-speed boats is better than might otherwise be expected because of the superior grade of gasoline (petrol) commonly employed and on account of the high piston speed.

The character of the cycle of the internal combustion engine, as compared with the steam engine, necessitates several peculiar features of auxiliary design in order to properly adapt it for the requirements of marine service. Thus, for starting in small sizes, the engine may be turned over by hand, the initial charge drawn in, and the start thus effected. In larger sizes, however, compressed air starting has become the rule. For moderate sizes this is effected by attaching to the engine a small air compressor, operated by an eccentric or crank, and provided with an automatic cut-out when the pressure has reached the desired limit of 200 or 250 pounds per square inch. The air thus compressed is stored in lengths of tubing or other form of receiver which can be located in otherwise useless space, and thus becomes available on demand for starting the engine or for blowing the whistle. In large sizes small auxiliary, hand-starting engines are provided, with connections in such manner that they may be used at will for compressing air, for running an electric generator for lights or for pumping.

Another special feature is the reverse. This may be brought about in three different ways. Thus the small-sized, two-cycle units will run in whichever direction they are started, and in this manner by hand the requirements of reverse and control are provided. This method, however, is limited to this type, and to small sizes, and can scarcely be considered as an adequate solution of the problem. For all engines of the four-cycle type the reverse may be effected either by a longitudinal shift of the cam shaft, thus bringing the valves under control of a new set of cams so placed as to determine motion in the reverse direction, or by a gear reverse in the shaft of the planetary type.

About 1905 attention became directed to the possibilities of double-acting gasoline (petrol) engines for marine service, and since that time engines of this type have gained recognition for cases where the power desired per cylinder is more than can readily be developed without undue increase in size. The serious problems of piston-rod packing, internal lubrication and cooling of working parts have been successfully dealt with, and the double-acting type may be considered as the latest product of the past decade in motors of this type.

The engines of the internal combustion type thus far considered have been primarily those using gasoline (petrol) as fuel. Astonishing as the progress has been with engines of this type, the progress during the last few years in the adaptation of oil-burning engines to the demands of marine service has been even more striking. Under this general head brief reference may be made to engines using kerosene (paraffin) engine distillate, and crude oil of various grades and characteristics. Most well-designed gasoline (petrol) engines with appropriate change in the carbureter can be made to run on kerosene (paraffin) or the lighter distillate by starting on gasoline (petrol) and switching over to the heavier fuel. For crude oil, refuse and fuels of such type, however, a complete change in the programme is required, and it is with such fuels that engines of the Diesel type have made the most remarkable advances during the past few years. Engines of this type are adapted to use fuels of widely varying characteristics, covering practically the entire range of the heavier hydro-carbon oils and their distilled products and with a *thermal* economy unattained, perhaps, by any other form of heat prime mover. They are heavier than gasoline (petrol) engines per horsepower developed and require careful supervision and care. Their valuable characteristics have, however, gained recognition to such an extent that we find them in use in both the naval and commercial marines in all sizes, including an English battleship design of 36,000 aggregate horsepower on three shafts. Typical sizes are, however, between 100 and 1,000 horsepower, with 4 or 6 cylinders, and with single or twin shafts. There have recently appeared, however, several designs, some of which are in operation, in which the power is in excess of 1,000 horsepower. The fuel economy of engines of this type will range from .4 to .5 pound per horsepower hour at near full load and up to .6 to .7 at one-third to one-quarter loads.

In addition to the gasoline (petrol) and Diesel types of engine, the internal combustion principle has furnished another strong competitor for certain types of marine service in the gas engine, using fuel furnished by a gas producer of the suction type. Such producers operate on coal fuel, preferably of the anthracite form, and furnish a gas having a heating value from 150 to 250 B. T. U. per cubic foot. The fuel economy of such plants is about one pound of anthracite coal per horsepower hour. The low-heating value of the gas requires higher compression than with gasoline (petrol) vapor and other minor changes in the design of the engine. In general, the engine design follows the characteristics which have been worked out in connection with the use of gas of this character, and with only such structural variations as would serve to adapt it to the requirements of marine service. The total weight of gas producer and engine in such an installation is much greater than in the case of the gasoline (petrol) or fuel oil engine alone, and for this reason such form of power installation is only suitable in craft intended for moderate or slow speeds.

Within these limitations, for canal boats, lighters, small cargo carriers, etc., there is a fair field for the further trial of power equipment of this character.

In the general field of internal combustion engines, gasoline (petrol) must, by reason of its price, be restricted to pleasure and racing craft, while the field of commercial use is open to either oil engines or producer gas equipment. At the present time the oil engine seems to be decidedly in the lead. Further experience alone, however, can determine their relative merits for different demands of service and the particular types or conditions for which one or the other may prove to have superior adaptation.

In the entire field of marine engineering the most notable feature during the past fifteen years has undoubtedly been the phenomenal advance which the internal combustion motor has made, and the point of greatest present uncertainty is, perhaps, the result of the competitive struggle which we see now going on among the various forms of marine power equipment.

Propulsion

From the time of its introduction early in the nineteenth century the screw propeller had won and maintained a place of continuously increasing importance as a means of marine propulsion, and by the last years of the century the field was quite definitely divided between the propeller and the paddle-wheel. During the fifteen years since that time the situation remains much the same, with perhaps some small further restriction in the field of the paddle-wheel. For river service where large craft may be required for navigation in shallow water, and in general for all cases where moderate or large-size and shallow draft are combined, the paddle-wheel still finds a useful and effective field of service. For the entire field of deep water craft, and in general wherever the draft is sufficient to secure the immersion needed by the propeller, the latter is the accepted and normal means of propulsion. Even in the field of shallow water craft the propeller has made advances during the past fifteen years, and, by means of special forms at the stern so adapted as to insure proper immersion for the propeller, the latter has shown its practicability for river and other craft of relatively light draft.

The paddle-wheel either as side wheel or stern wheel has remained in design and construction practically unchanged during the period under consideration. Here again we have, so far as the design and construction of the wheel itself is concerned, practically a finished engineering product, and so long as paddle-wheels are used at all there is no reason to anticipate any marked change in their characteristics of design or construction.

Regarding the screw propeller, there has accumulated during the period under consideration an enormous amount of experimental model data resulting from investigations in Europe and in the United States in Government and private experimental tanks, as a result of which the design of the propeller is placed on a much more secure footing than in the closing years of the last century. The results of these investigations show that propellers under favorable conditions may develop efficiencies of 70 percent or slightly better. The main problem has been therefore to so correlate these results as to indicate clearly the possibilities in any proposed case, and the combination of characteristics which will insure the maximum efficiency, or as near to such value as may be practicable. There is perhaps no problem in engineering the solution of which depends in so intricate a manner on the many factors which are required to define a given case. As a result, the design of the propeller must be in chief measure empirical, and with uncertainty regarding the suitable values to be assigned to various factors the results on the average must of necessity fall far below the maximum actually attainable. The really important problem during recent years has therefore been, not so much the design or development of some special type of propeller of hitherto unattainable efficiency, as the accumulation, analysis and correlation of experimental results in such manner as to make possible the general raising of the great mass of average practice. This important service has in large measure been rendered by the work of the past fifteen years, and, while much yet remains to be done, especially in outlying portions of the field, nevertheless the designer who makes suitable use of these accumulated stores of data may be assured, for the approximately normal case, of a result not far from the maximum permitted by his limiting conditions.

A problem of peculiar importance in connection with the application of the turbine to marine service has been the investigation of the propeller of high revolutions and low-pitch ratio. Before the advent of the turbine the usual pitch ratio ranged from 1 to 1.6 or 1.8. With the high rotative speeds of the turbine, pitch ratios .40 to 1 became common, opening up a new and unexplored field to the designer of the propeller. Experience with full-sized propellers, as well as model experiments, all confirm the general conclusion that the use of pitch ratios much below 1 is attended with a distinct loss in efficiency as compared with the higher pitch ratios typical of practice with the reciprocating type of prime mover. By an increase in size and a narrowing of the blades the loss may be minimized, but under ordinary working conditions some loss in efficiency must be anticipated in connection with the high rotary speeds of the turbine, and in such fact we find one of the relative disadvantages of the turbine type of motive-power equipment. The use of some form of reduction gear between the turbine and propeller, as elsewhere noted, is, in effect, a recognition of this fact.

The present typical screw propeller may have either three or four blades, each blade being of a generally elliptical or oval contour, carefully formed and in the best design surfaced by grinding on both front and rear faces. The blades may be either cast solid with the hub or detachable. In all large propellers the latter form prevails. Cast iron, cast steel and bronze are used according to grade and character of practice. The latter is always preferable on account of strength, toughness, smooth surface and low frictional resistance, and is always employed in the best practice.

Investigation shows that the present propeller under the best conditions approaches very close to the limit of possible efficiency, and that there is therefore but little gain to be expected in the maximum possible results. The outlying field which still remains, consists rather in an extension of the results of the past fifteen years, and the broadening of our foundation for the sure and effective treatment of every problem of propeller design in such manner as to insure the realization of the maximum efficiency compatible with the selected limiting conditions of operation.

Auxiliaries

Only brief mention need be made of auxiliaries so far as propulsive machinery is concerned. The same general kinds of auxiliary machinery have remained in use throughout the period under consideration, with occasional improvements or developments in type or detail. Thus blowers, pumps, condensers, etc., have remained in broad outline much the same during the past fifteen or twenty years. In detail and in particular types many improvements have been made. Thus the narrow vane or sirocco type fan has come forward and is accepted as superior in efficiency and general effectiveness to the older type. The centrifugal pump has become generally accepted as the typical form of pump for circulating water through the condenser. The functions of the air pump, especially for turbine service, have been subdivided, and the water of condensation, or condensate, is drawn out by a small centrifugal pump and passed along to the hot well, while the air is withdrawn by specially designed forms of so-called dry vacuum pumps. Of these there are three types at the service of the designer, the old and familiar piston type with specially improved details of valve movement and function, the rotary, represented by such pumps as the Rotrex, and more recently the Le Blanc type. Electric motor drive for auxiliaries such as centrifugal pumps and fans has become common, and in these general respects the practice in the marine engine and fire-room has kept well abreast of the many improvements in general engineering practice regarding such items of equipment as may serve a collateral or auxiliary service in

connection with the operation of the main propelling machinery.

Materials

One of the most significant features in connection with general engineering progress is the extent to which developments and improvements in one field are conditioned or made possible by progress in another. Nowhere is this more clearly shown than in the part which improved or new structural materials have played in making possible improvements in the field of marine design, especially in the line of increased power per pound of machinery or per ton of displacement, and in consequence higher speed or increased carrying capacity. The modern boiler, high-speed steam engine, turbine or internal combustion motor, line and propeller shafting and propeller itself, all depend in their present typical form and design on the possibilities which have been placed in the hands of designers of marine machinery by improvements in the constructive materials of engineering.

Special alloy steels such as nickel, vanadium, chrome, tungsten, etc., furnish, as may be desired, materials with the maximum combination of tensile, shear or compressive strength, toughness, hardness, resistance to high temperatures, or abrasion, and with any one combination of related qualities magnified to any degree within limits.

Again, special bronzes for propellers and bearing shells and a long line of special bearing metals have also contributed their quota in the developments during the past fifteen years. Limitations of space preclude any detailed examination of this subject, but in passing in review the various advances in the field of marine design and operation we must not forget that with regard to structural materials this period has contributed, perhaps beyond that of any other equal period, to the extension of the resources placed at the immediate disposal of the designer of marine machinery.

Size and Power

Continuous and definite though by no means startling advances in size and power of propelling machinery and in speed of ship have characterized the developments of the past fifteen years in the marine field.

In the early years of this period 10,000 horsepower per shaft with reciprocating engines was well within the limits of achievement. At the present time perhaps twice this amount or 20,000 horsepower per shaft may be considered as equally within the limits of practical realization. These larger amounts of power are for the most part with turbine installations. In this respect, regarding the size of the unit itself, and in particular since the diameter of the shaft depends on rotative speed and power, the turbine has a distinct advantage over the reciprocating engine, although, as previously noted, the application of the power through the propeller at high rotative speeds is less efficient than at low speeds. So far, however, as size and power of units per shaft are concerned, the progress has simply kept pace with the demand, and, within a limit which it would perhaps be difficult to set at the present time, there seems to be no reason why the size and power of such units should not continue to increase in answer to further demands along the same line. In addition, however, to an increase of power per shaft, the problem of increased total power has been further met by an increase in the number of shafts. This again is made the more possible with turbine installations by reason of the high rotative speeds and relatively smaller propellers.

The total power of propelling machinery has likewise grown in answer to the growth in two measurably distinct characteristics of ship design and operation; increasing speed by itself, and increasing size of ship. Either singly or both in combination demand increasing total propulsive powers. In the early years of the period under consideration, the maximum total propulsive power in large mercantile steamers was represented by amounts from 20,000 to 30,000 horsepower, for ships of 25,000 to 30,000 tons displacement and for speeds of about 22 knots. For warships of the battleship type the maximum power was represented by some 15,000 to 18,000 horsepower for ships of about 15,000 tons displacement, and at speeds of 18 or 19 knots.

At the present time the maximum in mercantile marine is represented by a total powers from 50,000 to 70,000 horsepower for ships of 40,000 to 60,000 tons displacement and for speeds 24 or 25 knots; while for warships the superdreadnoughts and battle cruisers require aggregate powers of 30,000 to 50,000 horsepower for displacements of 25,000 to 28,000 tons and speeds of 22 to 25 knots.

Economy

The advance in economy of propulsion by way of steam prime movers has been comparatively small during the period which we are considering. The reciprocating steam engine has only improved in minor degree. Superheated steam and higher steam pressures have advanced only moderately, and the gain which has been made in engine economy is small compared with the great changes which have been noted in other directions. Steam turbines operated at or near their most economical point, that is, at or near the single speed for which they are designed, have shown an economy on the whole better than reciprocating engines, though in the same general class, while, if used over a wide range of speed, the economy as noted elsewhere is distinctly inferior to that of the reciprocating engine. From 12 to 15 pounds of steam per shaft horsepower hour independent of auxiliaries will represent in the main results which good practice may now hope to attain. In special cases with superheated steam and particular attention to economy, the figures have been reduced close to 10 pounds. Auxiliaries included, these figures will be raised by 10 to 20 percent. These figures represent something from 1.1 to 1.5 pounds of coal per shaft horsepower hour for all purposes as typical of good present practice, figures which had been achieved in detached cases during the closing years of the last century. In smaller craft the situation is similar. Here the fuel consumption has remained without essential change from 1.5 pounds to three and four pounds, depending on conditions of operation.

The most significant outlook for improved economy seems to lie in connection with the internal combustion engine and in particular for small and moderate sizes. The economy of such forms of motor has already been noted, and when reduced to financial basis it readily appears that the crude oil motor and producer gas installations are the only types which seem to give definite assurance of reduced propulsive cost as compared with steam. If Diesel type motors can insure continued operation on .4 to .6 pound of oil per shaft horsepower hour, then, with a not improbable relative cost between coal and oil, the latter will be able to show a marked saving as compared with coal, and this on fuel cost alone. If in addition allowance be made for saving in personnel and general fire-room expense, the gain will be still more significant.

With producer gas installations giving a shaft horsepower hour for about one pound coal, the saving will be relatively small in large high-grade practice, but more in small craft, where high efficiency is more difficult to obtain with steam prime movers than with internal combustion engines.

On the whole, we must accord to the internal combustion motor, and in particular to the Diesel type, credit for the most significant progress during the past fifteen years and for the most hopeful promises for the future regarding the important features of economy in the development of power for marine propulsion.

Possibilities of Montauk Point Relative to the Atlantic Express Passenger and Mail Service

BY WILLIAM T. DONNELLY*

This is a subject which has been under discussion for a great many years, and one which has been brought to my attention on numerous occasions, and until very recently I have been very pronounced in my attitude as to the unreasonableness of any such undertaking, but the persistency with which this matter has been agitated has led me to give it considerable study, and this has developed an entirely different point of view, which, while it may not be conclusive, seems to be sufficiently sound to warrant some consideration.

The general discussion of this subject has always tended toward the possibility of a freight line and cheap shipping facilities, and from this point of view I can see no possibility of a development, as the approach would be limited to the tracks of the Pennsylvania Railroad. My new point of view is the possibility of an express, passenger and mail service. It is apparent that, due to the shorter distance and the ease of entering the port at Fort Pond Bay, Montauk Point, Long Island, the *Mauretania* and the *Lusitania* could shorten their trips by about seven hours. This does not seem much on the face of it, but it would mean fourteen days a year or two more trips for each vessel in the year, and this without the expenditure of any additional coal and without any additional expenditure for officers and crew. Reduced to its lowest term, this means, with the same investment of capital, the same maintenance and expense accounts, the adding of an enormous sum to the earning capacity, not simply the 4 percent represented by two additional trips in fifty, but a very much greater amount, due to the fact that nearly the total receipts of these two trips would be added to the profits.

If this terminal can be brought about, mainly at the expense of the United States Government and the Pennsylvania Railroad, it would seem to be a very handsome thing for the steamship company, and, considered from the railroad point of view, it would seem to have attraction enough for the Pennsylvania Railroad to make them interested, as they would have the only direct through-rail connection to the fastest passenger and mail line across the Atlantic.

Of course, we have to consider the alternative, such as saving by sailing from Boston, Mass., and other far Eastern ports, but I would point out that it will be practically impossible to take away from New York the distinction and prestige of the most direct and highest class connection with Europe, and, as regards Boston and New York, Montauk Point would be a neutral point and would put Boston in almost as good position relative to the point of departure as New York City.

Granting the project as outlined as a possibility, the relative position of the Canadian Grand Trunk System to such a development is a point of interest. The distance from New London, Conn., to Montreal, Canada, is 376 miles and the distance from Montauk Point to New London 20 miles by water. To make this comparable to railroad miles, I have multiplied it by 3, or called it 60 miles. This would make the distance from Montauk Point to Montreal 436 miles. The distance from Montauk Point to New York City is 118 miles and from New York to Montreal 399 miles, or a distance of 517 miles, which gives 81 miles relative advantage by the Central Vermont Railroad from Montauk Point to Montreal.

The question then is, whether this would be sufficient to give the Grand Trunk Pacific Railway the control of the fastest mail and passenger route from Montreal, Canada, and the Northwest, as against any other possible connection. If this would work out, it would appear to offer some additional inducement for the adoption of Montauk Point as a point of departure for the transatlantic express passenger and mail service.

Of course, the question will be raised as to New London as a point of departure; but I think this will be impossible, as in any rail contest the Pennsylvania Railroad would always dominate the New York, New Haven & Hartford Railroad, and, besides that, the concession of such a terminal to Connecticut by the great State of New York is practically out of the question. It is quite possible, however, that if the express passenger and mail service should leave Montauk Point, the general agitation of the subject might develop a secondary line of freight and passenger service from New London to Europe, as New London has one of the best and most accessible harbors on the coast; and, of course, this would be of great advantage to New England.

In any discussion of this subject, our friends in Canada will insist upon the consideration of one of their Eastern ports, such as Halifax, Nova Scotia, which is free from ice the year round.

I make the railroad distance from Halifax to Montreal 836 miles and the distance from Montauk Point to Montreal, as previously stated, 436 miles, a difference of 400 miles in favor of Montauk Point. For a matter of comparison, I will turn this distance into time by using 50 miles per hour as the common mail transportation speed. This gives Montauk Point eight hours' preference over Halifax in relative rail distance.

I find that the fastest steamers from Halifax are the *Virginian* and the *Victorian*, making 18 knots. To make the comparison more simple, I will turn the eight hours' time into added distance between the Port of Halifax and Liverpool. Eight hours at 18 knots would mean 144 knots. This, added to the distance from Halifax to Liverpool, 2,485 miles, would make 2,629 miles, and this distance, at 18 knots, would require 146 hours.

The distance from New York to Plymouth is 2,973 miles. Allowing 125 miles between New York and Montauk Point, would make a sailing distance of 2,828 miles. The speed of the *Mauretania* and *Lusitania* is 25½ knots. This would make the sailing time 111.6 hours, or a saving over the Montauk route, as compared with the Halifax route, of 34.4 hours.

It is, of course, apparent that this advantage of Montauk Point is due to the difference in speed of the boats, which brings the question down to the consideration as to whether this difference will be continued. In this connection, the first point to be decided is the speed of the boats that would be required to put Halifax on an equal footing with Montauk Point. This is readily obtained by dividing the Halifax mileage by the time consumed in traveling the Montauk course. This gives the required speed as 23.5 knots. While it is, of course, entirely within the bounds of possibility that boats of such a speed may be run from Halifax, I do not consider it at all practicable. To obtain this speed with any degree of regularity, the boats would have to be of tremendous power and very large size, and to return anything upon the investment they must receive a tremendous subsidy, as they could not receive anything like the patronage assured to a line directly connecting such a city as New York.

It may be of interest to consider briefly the actual financial sums involved in such a transatlantic line as is referred to. The cost of the *Mauretania* and *Lusitania* was approximately $6,500,000 (£1,337,000) each. The capital for these vessels was loaned by the British Government at a rate of interest approximating 2¾ percent. It is a very reasonable supposition that this line is operated for a net return of this amount plus 5 percent, or a total net revenue of 7¾ percent

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per annum. This would mean a net revenue of $503,750 (£103,700) per year, or, figuring on a basis of fifty trips, would mean approximately $10,000 (£2,055) per trip.

It would be entirely within the bounds of business experience to estimate the net receipts from a trip as not more than 20 percent of the gross receipts. On this basis, the returns from two additional trips would be an additional $100,000 (£20,550) per year, an amount equal to 20 percent of the present total net revenue.

The foregoing is not intended to be an accurate presentation of the facts, but is believed to be substantially correct, and is intended to be an illustration of the economic principles involved in the greatest possible utilization of revenue-earning power of transportation means.

New Tank Steamer for the Gulf Refining Company

The Gulf Refining Company, of Pittsburg, Pa., has under construction a new tank steamer which will have a greater bulk of oil-carrying capacity than any other tank vessel operating under the American flag with the exception of the *Oklahoma,* which is owned by the same company.

Contract for the new tank steamer, which is to be named the *Gulfoil,* was placed with the New York Shipbuilding Company, Camden, N. J., and the vessel is being built from designs prepared by Mr. George B. Drake, New York, the naval architect, who also designed the *Oklahoma* and other craft for the same owners.

The *Gulfoil is* being built to the highest class in Lloyds and under Lloyds special survey. The dimensions of the ship are as follows:

Length over all	406 feet 6 inches
Length between perpendiculars (Lloyds)	392 feet
Beam, molded	51 feet
Depth, molded to upper deck	30 feet 2 inches
Depth to main deck	22 feet 8 inches
Deadweight carrying capacity on 23 feet 6 inches draft	7,257 tons

The steamer is of the two-deck type with raised forecastle bridge and poop decks with a continuous expansion trunk between decks and a raised expansion trunk above the upper deck over the five after tanks. The expansion trunk sides, both between decks and above the upper deck, are continued by the machinery casing, thus greatly increasing the strength of the ship. The full poop will add greatly to the dryness of the ship and to the comfort of the crew. The main scantlings for the construction of the hull are shown on the midship section, and the arrangement of the transverses, longitudinals, bulkheads and decks is shown on the general plans.

Instead of following the usual method of construction, the owners decided to adopt the Isherwood System, consisting of longitudinal instead of transverse framing, a system now being used extensively in Europe, although this is the first tanker of this type to be contracted for in the United States. The results will no doubt receive considerable attention, particularly in view of the fact that, in addition to the practical advantage attained, a very material saving in weight of structural material has been effected, together with an increase of longitudinal strength as compared with the ordinary construction, resulting in an appreciable saving in the first cost of the vessel, as well as securing an additional carrying capacity of about 230 tons beyond what would be obtained in a ship of similar dimensions built under the old method.

When fully loaded the vessel will carry 2,285,000 gallons of oil in bulk, contained in twenty-two separate oil-tight compartments, in addition to which there are also a large cargo hold, and smaller compartments, furnished with all the necessary cargo booms, winches and handling gear, in which barreled oil or general cargo can be transported.

The steering engine will be a Brown steam tiller fitted direct on the rudder stock and worked from the bridge, as well as from aft, by the latest type of telemotor gear, while for additional safety there is also an independent hand gear, which can be used to steer the ship when occasion requires.

On the stern of the ship there will be placed a powerful automatic machine, furnished with a heavy steel hawser, for towing purposes; the anticipation being that this steamer, like others of the fleet, will have a barge as a consort, and for that reason a considerable margin has been allowed in the proportions of the machinery so that there may be no appreciable delay to the steamer, even in the event of her having a barge in tow.

The ship's officers and operator for the wireless system, with which the vessel will be equipped, are provided with adequate and comfortable quarters amidships, in a house raised above the bridge deck and communicating with the after part of the vessel, where the dining saloon is located, by means of a substantial fore-and-aft bridge. The engineers, petty officers and all other members of the crew, are suitably housed under the raised poop deck, aft. The galley, saloon and petty officers' mess are located in a steel house in the poop deck and the crew's mess rooms, steward's storerooms and other essential accommodations are located under the poop deck, thereby minimizing and confining the work of the steward's department within as small an area as possible.

As on all the vessels operated by this company, oil will be used as fuel and will be carried in bunkers having a capacity of 176,000 gallons, so arranged at both ends of the vessel that either cargo or fuel can be carried therein; which arrangement also permits of considerable latitude in trimming the boat to suit the different conditions of loading.

The cargo-pumping arrangement, due to the many different grades of oil likely to be carried in the numerous compartments, is of necessity somewhat elaborate. Considerable attention has been given to this feature, in connection with the excellent loading facilities provided at the company's new docks at Port Arthur, resulting in a simple and efficient arrangement of pumps and piping. In all there will be seven pumps of the Warren Steam Pump Company make. Six of these are 10 inches by 8½ inches by 12 inches duplex, and the other 12 inches by 10 inches by 12 inches duplex. Each pump is capable of discharging cargo at the same time, through an independent line. In the pump room, which is at the after end of the cargo tanks, there will also be installed an air compressor, which can be used for testing lines, operating pneumatic tools and various other purposes for which compressed air can be utilized.

Machinery

Following the usual custom the propelling machinery is placed aft. The main engine is of the vertical, inverted, triple-expansion type, surface condensing, with three cranks at angles of 120 degrees. The cylinders are 27 inches, 45 inches and 75 inches diameter, with a common stroke of 48 inches. The high-pressure cylinder is forward and the low-pressure aft. The high-pressure and intermediate-pressure valves are of the

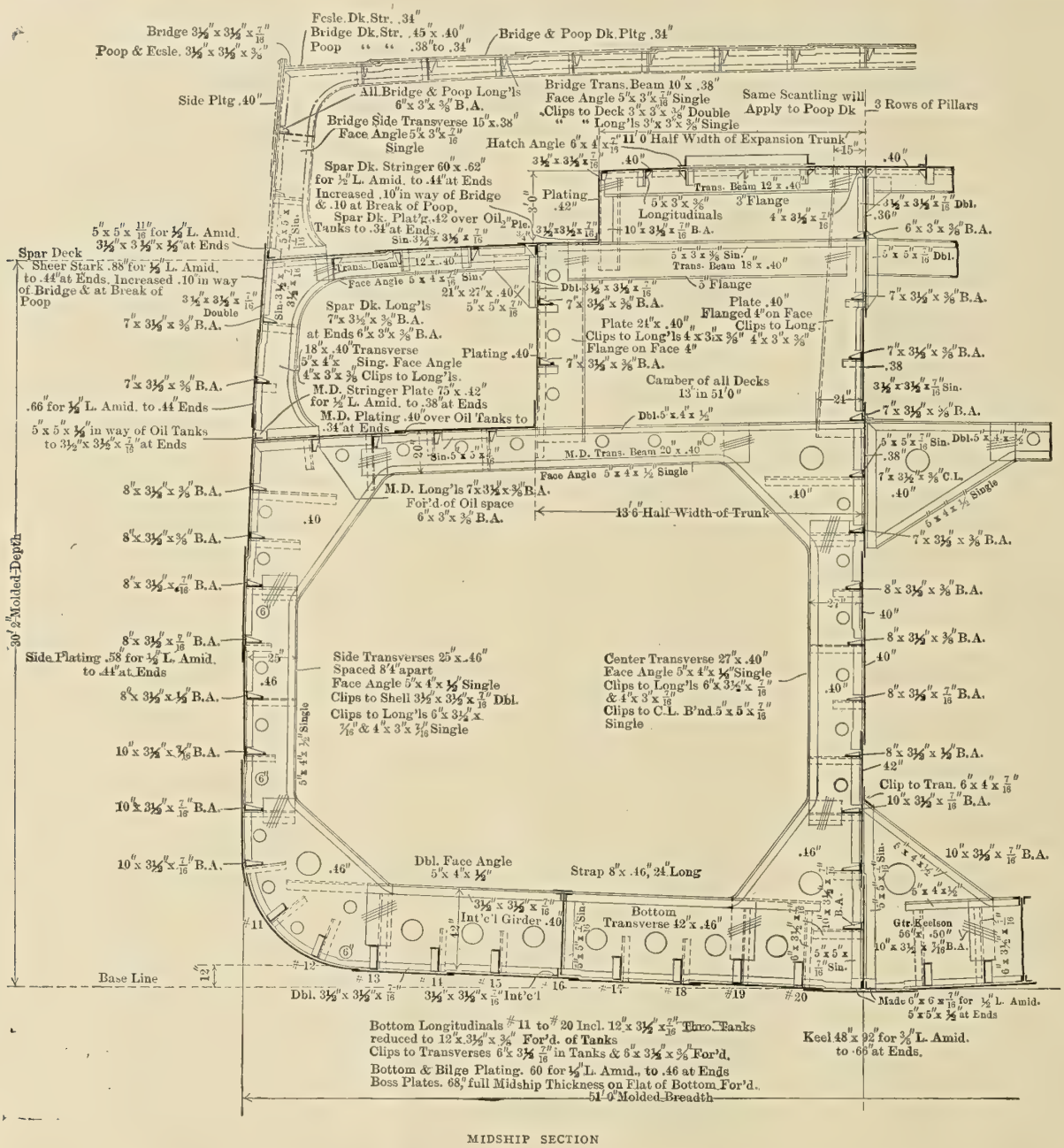
piston type and the low-pressure valve a balanced slide valve. All of the valves are operated by the Stephenson link reversible gear. The intermediate and low-pressure valves are to be equipped with Lovekin assistant cylinders. The engines, when working at their maximum power, will develop 2,700 indicated horsepower, which will give the vessel an average sea speed of 11½ knots.

The main condenser, which is independent of the main engine, is of the cylindrical type, containing 4,800 square feet of cooling surface, designed to maintain a vacuum of 26½ inches, with circulating water at 86 degrees Fahrenheit.

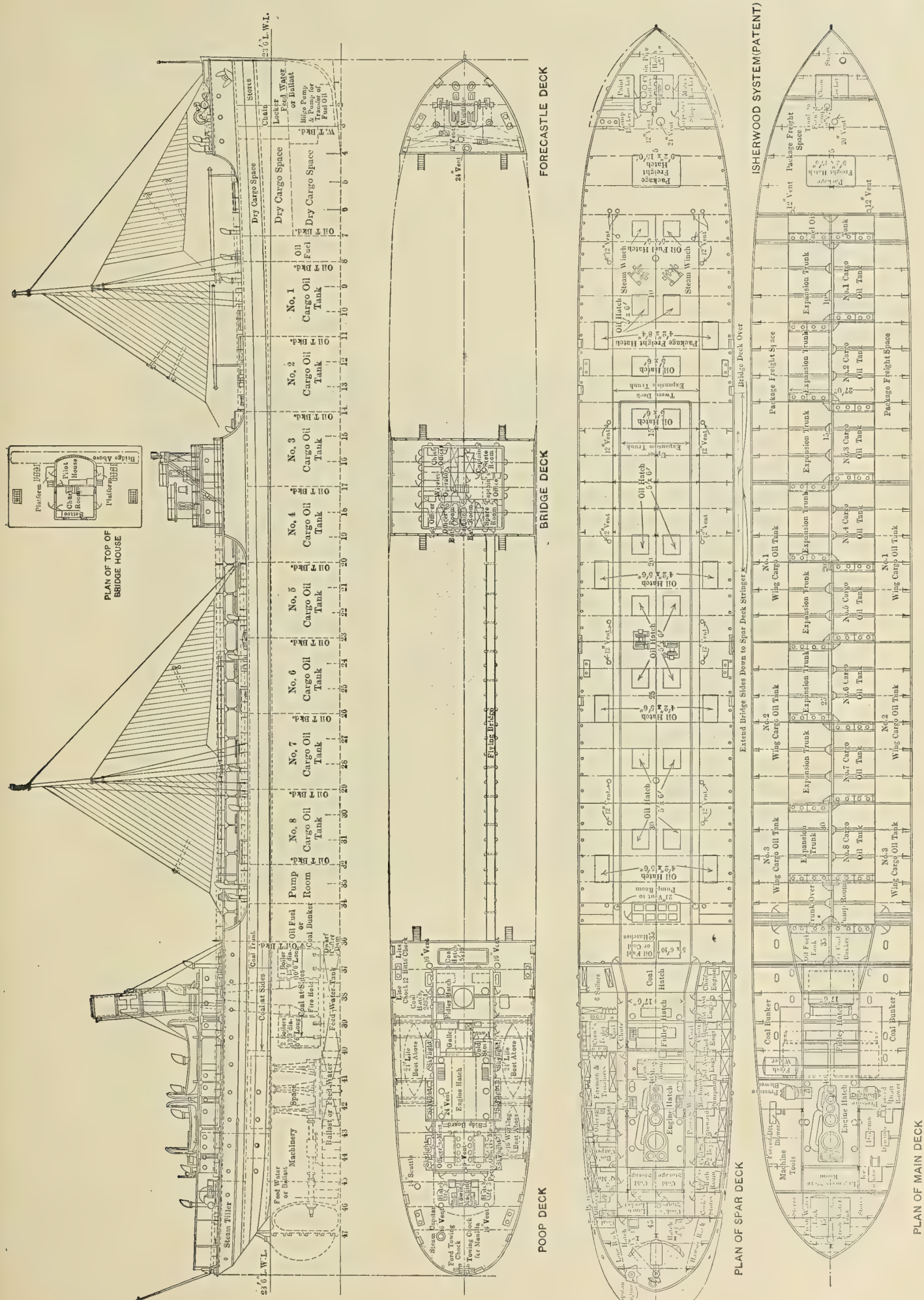
The reversing gear is of the ram type secured to the main engine, and there is a steam-turning gear with a single cylinder reversing engine operating a shaft and a worm engaging a worm wheel on the main crank-shaft. The thrust bearing is of the horseshoe type fitted with ten collars. One main air pump, two bilge pumps and one sanitary pump are driven direct from the low-pressure crosshead. These are single-acting, arranged vertically.

The main feed pump is a vertical, single, long-stroke pump of the Weir type, 12 inches by 8½ inches by 16 inches. An auxiliary feed pump of the same size will also be fitted. There is one donkey pump of the horizontal duplex piston type, 12 inches by 10 inches by 12 inches. Also two pumps, one for water service and sanitary purposes and the other for fresh water of the horizontal duplex piston type, 5 inches by 4¾ inches by 6 inches. The circulating pump is of the centrifugal type, operated by a single vertical engine. An auxiliary condenser of 900 square feet cooling surface is furnished with air and circulating pumps to provide for all the pumps and auxiliaries. A Griscom-Spencer evaporator of 25 tons capacity in twenty-four hours and a Griscom-Spencer feed water heater of 225 square feet heating surface are installed.

In addition to the usual auxiliaries required in the engine room, the vessel will be furnished with a two-ton ice machine, connected with ample cold-storage capacity, thereby enabling the vessel always to be well supplied with an abundance of fresh stores. There will also be fitted in the engine


Spar Deck
Sheer Stark .88" for ½" L. Amid. to .44" at Ends. Increased .10" in way of Bridge & at Break of Poop
Side Plating .58" for ½" L. Amid. to .44" at Ends
Side Pltg .40"
Bridge & Poop Dk. Plting .34"
Fcsle. Dk. Str. .34"
Bridge Dk. Str. .45" x .40"
Poop " " .38" to .34"
All Bridge & Poop Long'ls 6" x 3" x 3/8" B.A.
Bridge Side Transverse 15" x .38" Face Angle 5" x 3" x 7/16" Single
Bridge Trans. Beam 10" x .38" Face Angle 5" x 3" x 7/16" Single
Clips to Deck 3" x 3" x 3/8" Double
" " Long'ls 3" x 3" x 3/8" Single
Same Scantling will Apply to Poop Dk
3 Rows of Pillars
Hatch Angle 6" x 4" x 7/16"
11' 0" Half Width of Expansion Trunk
Spar Dk. Stringer 60" x .62" for ½" L. Amid. to .44" at Ends
Increased .10" in way of Bridge & .10 at Break of Poop.
Spar Dk. Plat'g. .42 over Oil Tanks to .34" at Ends
Plating .42"
Trans. Beam 12" x .40"
3" Flange
Longitudinals
Trans. Beam 18" x .40"
5" Flange
Plate .40" Flanged 4" on Face
Clips to Long'ls 4" x 3" x 3/8" 4" x 3" x 3/8"
Plate 24" x .40"
Clips to Long'ls 4" x 3" x 3/8" Flange on Face 4"
Spar Dk. Long'ls 7" x 3½" x 3/8" B.A. at Ends 6" x 3" x 3/8" B.A.
18" x .40" Transverse
Plating .40"
5" x 4" x Sing. Face Angle 4" x 3" x 3/8" Clips to Long'ls.
M.D. Stringer Plate 75" x .42" for ½" L. Amid. to .38" at Ends
M.D. Plating .40" over Oil Tanks to .34" at Ends
.66" for ½" L. Amid. to .44" Ends
5" x 5" x ½" in way of Oil Tanks to 3½" x 3½" x 7/16" at Ends
Camber of all Decks 13" in 51' 0"
Dbl. 5" x 4" x ½"
M.D. Trans. Beam 20" x .40"
Face Angle 5" x 4" x ½" Single
M.D. Long'ls 7" x 3½" x 3/8" B.A.
For'd. of Oil space 6" x 3" x 3/8" B.A.
13' 6" Half-Width-of-Trunk
30' 2" Molded Depth
Side Transverses 25" x .46" Spaced 8' 4" apart
Face Angle 5" x 4" x ½" Single
Clips to Shell 3½" x 3½" x 7/16" Dbl.
Clips to Long'ls 6" x 3½" x 7/16" & 4" x 3" x 7/16" Single
Center Transverse 27" x .40"
Face Angle 5" x 4" x ½" Single
Clips to Long'ls 6" x 3½" x 7/16" & 4" x 3" x 7/16"
Clips to C.L. B'nd. 5" x 5" x 7/16" Single
Dbl. Face Angle 5" x 4" x ½"
Strap 8" x .46" 24" Long
Int'c'l Girder .40"
Bottom Transverse 42" x .46"
Gtr. Keelson 56" x .50"
Base Line
Dbl. 3½" x 3½" x 7/16"
3½" x 3½" x 7/16" Int'c'l
Made 6" x 6" x 7/16" for ½" L. Amid. 5" x 5" x ½" at Ends
Bottom Longitudinals #11 to #20 Incl. 12" x 3½" x 7/16" Thro. Tanks reduced to 12" x 3½" x ¾" For'd. of Tanks
Clips to Transverses 6" x 3½" x 7/16" in Tanks & 5" x 3½" x 3/8" For'd.
Keel 48" x 92" for ⅜" L. Amid. to .66" at Ends.
Bottom & Bilge Plating. 60 for ½" L. Amid., to .46 at Ends
Boss Plates. 68" full Midship Thickness on Flat of Bottom For'd.
51' 0" Molded Breadth

MIDSHIP SECTION


ISHERWOOD SYSTEM (PATENT)
GENERAL PLANS
PLAN OF TOP OF BRIDGE HOUSE
FORECASTLE DECK
BRIDGE DECK
POOP DECK
PLAN OF SPAR DECK
PLAN OF MAIN DECK
Extend Bridge Sides Down to Spar Deck Stringer
Bridge Deck Over
Dry Cargo Space
No. 1 Cargo Oil Tank
No. 2 Cargo Oil Tank
No. 3 Cargo Oil Tank
No. 4 Cargo Oil Tank
No. 5 Cargo Oil Tank
No. 6 Cargo Oil Tank
No. 7 Cargo Oil Tank
No. 8 Cargo Oil Tank
Pump Room
Oil Fuel
Machinery Space
Coal Bunker
Package Freight Space
Expansion Trunk
Oil Hatch
Coal Hatch
Engine Hatch
Firing Bridge
Steam Tiller
Steering Gear
Chart Room
Pilot House
Bridge Above
Platform 1st Off.
Platform 2nd Off.
Stores
Chain Locker
Feed Water or Ballast
Bilge Pump & Pump for Transfer of Fuel Oil
Coal Bunker
Fire Hold
Feed-Water Tank
Ballast or Feed-Water
Coal Trunk
Coal at Sides
Deep Tank
Boilers
Donkey Boiler
Engine Room
Stokehold
Saloon
Galley
Store
Engineers' Mess Room
Engineers' Cabin
Spare Cabin
Spare Room
Officers' Cabin
Officers' Mess Room
Captain's Cabin
Captain's Room
Chief Engineer's Cabin
Chief Engineer's Room
Wireless Cabin
Wireless Room
Boatswain's Store
Carpenter's Store
Lamp Room
Engine Room Store
Donkey Boiler
Steam Winch
Oil Fuel Hatch
Package Freight Hatch
Fidley Hatch
Ventilator
Air Pipe
Boat Above
Life Boat
Life Buoy
Ford Towing Chock
Towing Clock for Manilla
Steam Capstan
Steam Windlass
Steam Steering Gear
Steam Boat Davit
Steam Boat Winch
Steam Whistle
Steam Pipe
Steam Line
Steam Exhaust
Steam Heating
Steam Blower
Steam Pump
Steam Donkey Pump
Steam Ash Hoist
Steam Coal Hoist
Steam Capstan
Steam Windlass
Steam Steering Gear
Steam Boat Davit
Steam Boat Winch
Steam Whistle
Steam Pipe
Steam Line
Steam Exhaust
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Steam Blower
Steam Pump
Steam Donkey Pump
Steam Ash Hoist
Steam Coal Hoist
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Steam Pipe
Steam Line
Steam Exhaust
Steam Heating
Steam Blower
Steam Pump
Steam Donkey Pump
Steam Ash Hoist
Steam Coal Hoist

room an up-to-date machine shop, supplied with an electrically driven lathe, shaper and drill press and a complete outfit of tools necessary for effecting such ordinary upkeep and repairs as have to be dealt with.

Steam is furnished at a pressure of 190 pounds per square inch by three single-ended Scotch boilers, which have an inside diameter of 14 feet 8 inches, and the length between heads is 11 feet. Each boiler has three Morison corrugated furnaces, 42 inches inside diameter. The tubes are of seamless cold drawn steel, 2½ inches diameter. The boilers are fitted so that either oil or coal can be used for fuel, but they are primarily equipped for oil burning. Each boiler is equipped with a water purifier, oil separator, heater and circulator located in the top of the boilers and connected up to the main and auxiliary feed lines provided with blow-off pipes. A forced draft system of the hot-air type is installed, two blowers being located in the engine room and direct-driven by vertical engines. The blowers will be of size to maintain an air pressure in the ash pit equal to a column of water 2 inches in height.

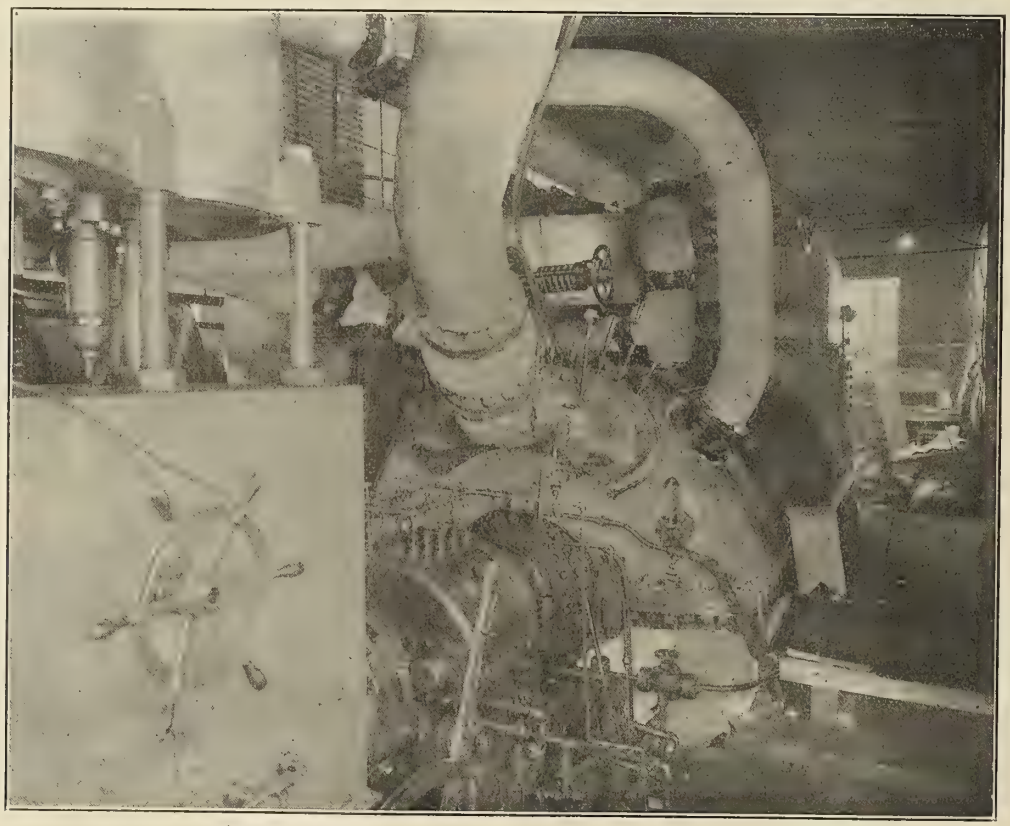
The oil fuel system is designed so that a mechanical atomizing system can be used. Each furnace will be equipped with one burner. Two duplex oil fuel pumps, 5¼ inches by 3½ inches by 5 inches, are connected to steam and exhaust lines and two oil heaters are located in the boiler room. The pump is arranged to draw from the oil fuel tank manifolds and discharge through an equalizing tank and the oil heaters, or direct, into a distributing system on the boiler fronts.

The electric plant consists of two 10 kilowatt General Electric marine direct connected sets for 110 volts, driven by vertical engines located on the main deck in the engine space.

In conclusion, it might be said of this vessel that a large cargo is being carried on limited proportions, without sacrificing either speed or durability, while every attention has been given to economy in working and facilities for operation, and that, with this valuable addition, the carrying capacity of the company's fleet is increased by about forty million gallons per annum, so providing equipment of the most modern type to meet the requirements of a rapidly growing business.

Tests of a Combination Reciprocating Engine and Curtis Turbine Unit

The Fore River Shipbuilding Company, of Quincy, Mass., has recently completed a series of tests of the machinery for one shaft of one of the later United States destroyers. This machinery was designed primarily to secure the maximum economy at low speeds of the vessel while maintaining the advantage of the turbine installation at the higher speeds, and consists of a 63-inch, 18-stage Curtis marine turbine, to the forward end of which a compound reciprocating engine is attached, by means of a clutch, which permits of this engine being connected or disconnected at will.



VIEW OF COMBINATION MACHINERY IN FORE RIVER SHOPS, SHOWING THE TURBINE

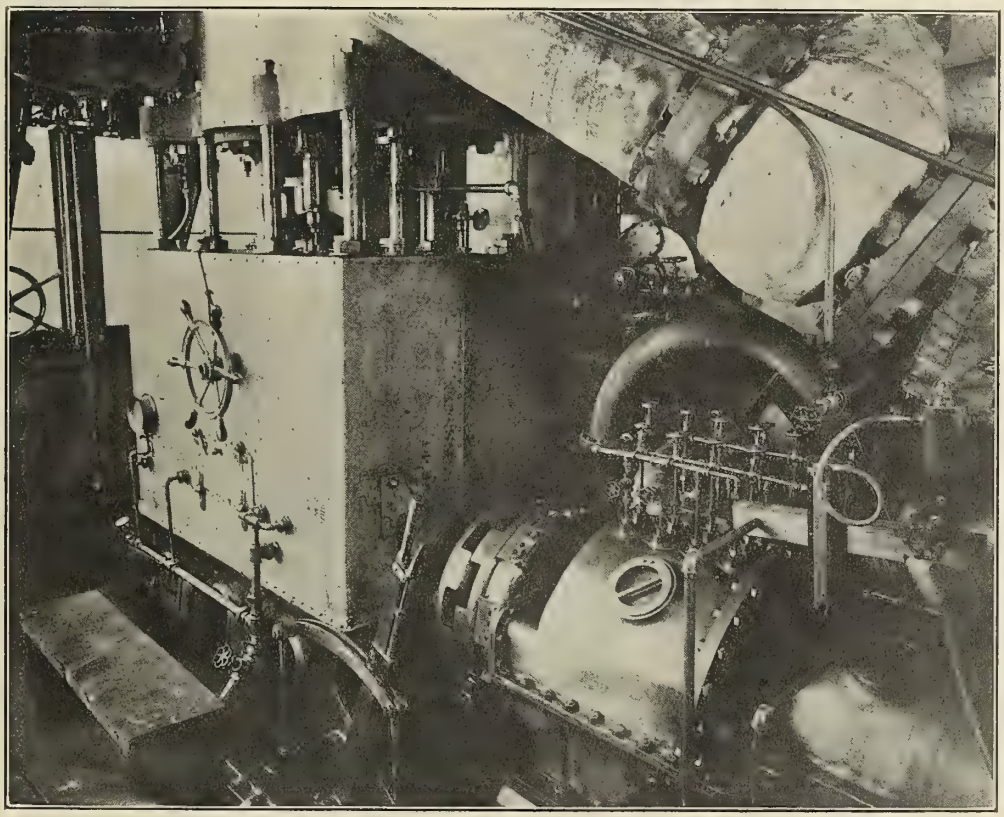
As set up for test, the installation consists of the above mentioned turbine and reciprocating engine, together with its condenser, circulating pump and air pump and one length of line shafting carrying two torsion meters of different makes for the measurement of the power. To the end of this shaft is connected a Froude absorption dynamometer with a brake arm carrying known weights so that the power absorbed can be accurately determined. This also serves as a check on the torsion meters.

The steam for the test was furnished by two watertube boilers which are a part of the regular equipment of the yard. The steam for the auxiliaries was taken from the same line, but they were allowed to exhaust into the open air, so that only the steam used in the main engines went through the

UNITED STATES DESTROYER *HENLEY*. SHOP TEST OF STARBOARD UNIT. SUMMARY OF TESTS—DECEMBER 27-28, 1911.

Test No.	Duration of Test.	Main Steam		Steam at Turbine Chest		Turbine Exhaust. Lbs. Absolute.	R. P. M	B. H. P.	W. R. Lbs. Per B. H. P.		Percent Improvement of Combination over Turbine.			
		Pressure Lbs. Absolute.	Degrees Superheat.	Lbs. Absolute.	Degrees Superheat.				Actual.	Cor. To 28.5″ Vacuum.	Actual.	Corrected to 28.5″ Vacuum.	Corrected to Same Vacuum and Steam Cond.	
	hrs. min.													
4	1 ..	261.8	32.5	146.7	16.	.835	176.2	161.	39.7	39.	.....	.....	.....	Turbine 10 knots
5	1 18	262.3	0.	147.3	10.	.923	174.3	159.4	20.6	19.7	48.1	48.8	49.9	Combination
2	1 ..	259.0	49.	230.8	16.	.953	235.	352.5	28.2	27.2	.....	.....	.....	Turbine 13 knots
1	1 48	259.0	0.	216.5	5.4	.825	231.	347.	17.4	17.1	38.3	37.2	39.9	Combination
3	1 ..	256.5	62.5	220.	30.	1.01	290.4	622.	22.3	21.3	.....	.....	.....	Turbine 16 knots
6	1 30	260.1	59.	253.5	46.	.933	284.	608.	16.5	16.0	26.0	24.7	24.8	Combination
7	.. 30	260.3	75.	249.8	65.5	.928	284.	487.	14.6	14.0	34.6	34.2	.....	Compound Special

Test No. 6 had some live steam admitted to the turbine.
Test No. 7 had all steam passing through the reciprocating engine and is the true measure of the gain obtained at 16 knots.



VIEW OF COMBINATION MACHINERY IN FORE RIVER SHOPS, SHOWING RECIPROCATING ENGINE AND CLUTCH

condenser, from which it was taken by the air pump and delivered alternately to two tanks placed on scales, by means of which it was accurately weighed. The plant was equipped with all the necessary instruments for determining the pressure and quality of the steam admitted, the vacuum, revolutions per minute and other data required.

A series of tests was made, first, to determine the steam required per brake horsepower for the turbine alone when run at the power and revolutions per minute necessary to propel the ship at speeds of 10, 13 and 16 knots. Second, these were duplicated in respect to power and revolutions per minute, with the reciprocating engine in gear and exhausting into the first stage of the turbine. The results obtained are given in the accompanying table. These show a marked gain in economy obtained by the use of a reciprocating engine in combination with a turbine over the turbine alone, being 48.1 percent at the 10-knot condition, 38.3 percent at the 13-knot and 34.6 percent at the 16-knot condition.

The Eighth Annual New York Motor Boat Show, which was held at the Madison Square Garden Feb. 17th to the 24th, gave some indications of the rapid strides which the motor boat business has made in recent years. The numerous exhibits of both boats and motors and accessories showed that steady progress has been made in perfecting the various details which go to make up a successful boat of this type. Speed, of course, has played an important part in certain types of boats, and phenomenal results have been obtained with small-sized hydroplanes. The general tendency in the cruising type of boats has been towards more comfortable accommodations and greater conveniences for living on board than have been available previously. No radical improvements have been made in the development of engines, although the details in general have been bettered, and the engines have become a more reliable and useful machine for all classes of work. The appearance of a Diesel engine exhibit in this year's show is a new departure which offers much promise for the future.

New Orient Mail Steamer Orama For Australian Service

The new Orient liner *Orama* was built at Clydebank for the Orient Steam Navigation Company's new Australian service. She is a triple-screw steamer with a combination of reciprocating engines and turbines, and she completes the list of six vessels necessary to enable the Orient Company to carry out the terms of their mail contract with the Australian Government. This contract extends over twelve years and expires in 1920, and secures for the Orient Company an annual subsidy of $830,000 (£170,000).

The leading particulars of the *Orama* are as follows:

Length over all	569 feet.
Length between perpendiculars	550 feet.
Breadth, extreme	64 feet.
Depth to shelter deck	46 feet.
Draft	24 feet 6 inches.
Displacement	15,750 tons.
Speed at sea	18 knots.
Horsepower	12,000
Gross tonnage	13,000

The two sets of reciprocating engines are of the four-cylinder, triple-expansion, direct-acting inverted type, balanced on the Yarrow, Schlick-Tweedy system, and are arranged to take steam at 215 pounds per square inch. The cylinders are 27½, 42, 47 and 47 inches diameter, with a stroke of 54 inches in all cases. The valves admitting steam to the high-pressure and intermediate cylinders are of the piston type, while those for the low-pressure cylinders are of the flat type. The valve gear is of the usual link motion arrangement.

The low-pressure turbine, which is of the Parsons design, takes steam from the reciprocating engines. The rotor is built up of steel forgings, and the blading is of Parsons laced type, with brass distance pieces between the blades at their roots, and the lacing soldered on the edges. The turbine casing is of cast iron. The turbine is placed aft of the reciprocating engines, and is 11 feet diameter, designed to transmit one-third of the power.

The speed trials proved the arrangement of the machinery to be very economical. It was found that when burning a slightly less quantity of fuel per unit of grate surface, nine single-ended boilers sufficed where ten of the same size were required in the five earlier vessels, which had twin screws only. The speed trials were performed on the Clyde, and consisted of progressive runs on the measured mile, and continuous runs between the Cloch and Cumbrae Lights at 18½ knots, all of which proved highly satisfactory.

The *Orama* is built to the rules of Lloyd's register for the highest classification of that society. She is of the shelter deck class and has four tiers of beams below the shelter deck. There are ten watertight bulkheads sub-dividing the hull, and a cellular double bottom extends from fore and aft peak bulkheads. The double bottom carries 1,000 tons of water ballast, 500 tons of fresh water for ship's use, and 300 tons of fresh water for boiler feed reserve. The hull plating is of a uniform thickness of 15/20 inch, this thickness having been specially considered in relation to the frame spacing, which is 30 inches. The after framing is out-bossed around the side shafts, and the center shaft is carried in an ordinary stern frame having a small aperture. The rudder is of the straight type, having a single plate, and the stock is 12½ inches diameter.

The *Orama* is one of the most up-to-date liners on the Australian route. Her principal rooms are on the promenade deck. Forward is the first class lounge and music room, a spacious apartment decorated in Louis XVI. style, and aft are the first class smoke room, which is in Dutch colonial style, and the veranda café. The first cabin dining saloon is on the upper deck, and has separate tables for small parties. This room is decorated in Louis XVI. style, and the walls are in white and grey. The second and third cabin public rooms are correspondingly commodious and handsomely appointed throughout. There is accommodation for 293 first class passengers, 145 second class and 867 third class, all of it having been specially designed and fitted in order to meet the special conditions of the Australian trade.

NEW ORIENT LINER ORAMA, 13,000 TONS, 14,000 HORSEPOWER

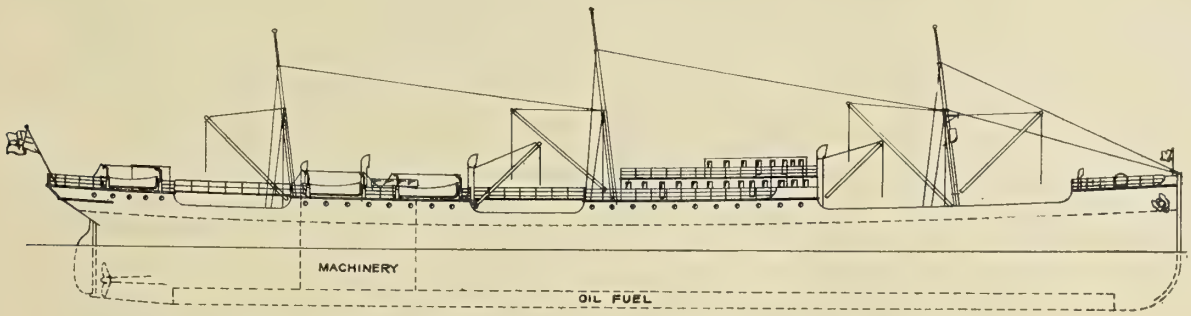
The cargo is carried in six holds, four forward and two aft. A large portion of the forward holds is insulated for carrying perishable cargo. The refrigerating machinery consists of two of Haslam's compound dry air machines of a capacity of 85,000 cubic feet, with a CO_2 machine of a refrigerative capacity of 15 tons.

There is an auxiliary or alternative steering gear of the

electro-hydraulic type associated with the names of Dr. Hele-Shaw and Mr. Martineau, which was described and illustrated at the spring meetings of the Institute of Naval Architects this year. The makers of both the ordinary steam gear and that of the new type, the two, however, having a working association, are Messrs. John Hastie & Company, Kilblain Engine Works, Greenock, and from tests with the gears made while the vessel was undergoing speed and other trials on the Clyde, and while on her voyage to the Thames, it is understood that the power required to steer her on a course was found to be only a little over 2 horsepower. This, it can readily be understood, represents an enormous saving in a vessel of the size of the *Orama*. The absence of lost motion between the steering wheel on the bridge and the rudder was exceedingly marked, and it was found that a very much smaller amount of motion of the steering wheel was required to steer the vessel.

for only twenty first class passengers—one-berth cabins of exceptional size, with toilet and bath for every two cabins—and an extra feature is the servants' rooms, arranged in connection with the private cabins. There is a commodious lounge, a handsome smoking room and a dining saloon in white "Louis-seize" style, with a height of 12 feet to the ceiling. This accommodation is arranged in the No. 1 "island," and here are also the rooms for the captain, the chart house and the navigating bridge. The officers are berthed in the No. 2 "island" around the engine room casing. Besides the usual mess-room there is also arranged a roomy smoking saloon for the officers' use. The crew is accommodated in the poop.

The accompanying sketch shows a general view of the ship and gives an idea of the small space occupied by the machinery. As a matter of fact the machine room and casing had to be made bigger than strictly necessary in order to get the usual reduction in the tonnage.



DANISH MOTOR SHIP SELANDIA, 6,800 TONS DEADWEIGHT CARRYING CAPACITY, 2,500 HORSEPOWER

The Diesel Motor Ship Selandia

BY AXEL HOLM

A prominent Danish trading firm—the East Asiatic Company, Ltd.—is at present building three sister ships, two in Denmark and one in Scotland, for their Oriental service, which are to be fitted with Diesel motors. The following is a brief description of the first Danish-built ship, the *Selandia*, now nearing completion in the yards of the firm of Burmeister & Wain, shipbuilders and engineers, of Copenhagen. She was launched on Nov. 4, 1911, and will be turned over to the owners late in February. The *Selandia* is built for the route between Scandinavia, Genoa, Italy, and Bangkok, Siam. She is a twin-screw ship with a continuous main deck of steel, a forecastle, two "islands" and a poop deck and with three schooner-rigged masts. The main dimensions are: Length between perpendiculars, 370 feet; breadth, molded, 53 feet, and a deadweight capacity of 6,800 tons on a mean draft of 22 feet 6 inches. As there is only 13 feet over the bar at the port of Bangkok, Siam, she will be able to carry only 2,700 tons to the harbor in her holds, the remainder being transshipped into barges. The crude oil for the fuel is carried in the cellular double bottom.

The twin screws are driven each by an eight-cylinder, four-cycle Diesel engine of 1,250 horsepower. The engines are of the enclosed type, having both crosshead and piston rod. The reversing is done by moving the reversing shaft on the engines lengthwise by means of a single lever working on the air-driven starting engine. This arrangement has been patented by the firm.

The auxiliary machinery consists of two Diesel motors of 200 effective horsepower each, direct coupled to dynamos for supplying current to the air compressors, the deck machinery, windlass and winches and for lighting the accommodation. The mizzen mast is used for the motors' exhaust, and the main mast is arranged as a smokestack for the galley.

The accommodation is very ample and rather luxurious, fitted up for the passengers and officers. There will be cabins

Performance of the U. S. Collier Neptune

In July last year the United States collier *Neptune*, after having undergone her official speed trials, was temporarily taken over by the Government, subject, however, to the subsequent fulfillment of contract requirements.

Referring to an article which appeared in this journal of October, 1911, it will be noticed that, according to contract, an average speed of 14 knots must be maintained on a continuous 48-hour trial under full-load conditions inclusive of certain other weights, and that the coal consumption for all purposes must not exceed 1.8 pounds per indicated horsepower per hour, figured on the power developed by the main engines. At the trials referred to the average speed obtained was 12.926 knots, the collective brake horsepower of turbines 5,409, or the equivalent indicated horsepower 5,879, and the coal consumption 1.791 pounds per indicated horsepower per hour.

The unsatisfactory results were attributed mainly to very inefficient screw propellers, and possibly to inadequacy of the turbines. It will be recalled in this connection that the ship in question is fitted with a mechanical reduction gear, as finally adopted by the Westinghouse Machine Company, operating in conjunction with a new type of Westinghouse marine steam turbine. As a preliminary step, with a view to remedying the failure in fulfilling the requirements, it was decided to make new screw propellers, which were laid down by the Bureau of Steam Engineering, Navy Department, from a design directed by Capt. C. W. Dyson, U. S. N. In the trials performed recently with the new propellers the results obtained were most satisfactory, both as to speed and coal consumption. The principal differences between old and new propellers will be found in the comparison appended below:

	Old Propellers	New Propellers
Type	Built Up	Solid
Number of blades	4	3
Diameter	14 ft. 6 ins.	14 ft. 8 ins.
Pitch	12 ft. 6 ins.	12 ft. 1 in.
Projected blade area	61 sq. ft.	50.68 sq. ft.

Trial results	Old Propellers	New Propellers
Speed	12.926 knots	14 knots
Revolutions per minute.	119.5	131.7
Coal consumption per I. H. P. per hour, turbines only	1.791 pounds	1.63 pounds
Shaft-horsepower	5,409	5,980

Maximum speed attained with new propellers was 14.24 knots, with a corresponding shaft horsepower of 6,310. The propulsive efficiency figures out about 65.6 percent. The higher number of revolutions per minute with the propellers aided materially in enhancing the steam economy of the turbines, and therefore a reduction in coal per horsepower.

Steamship Cap Finisterre

We show herewith a view of the steamship *Cap Finisterre,* the latest addition to the Hamburg South American Steamship Company's fleet. Built by Messrs. Blohm & Voss, Hamburg, she is of 16,500 gross tons, and is by far the largest vessel engaged in the River Plate trade. She is 560 feet long and 65 feet breadth, driven by two quadruple expansion engines of 11,000 horsepower, which will give an average speed of 17 knots. Her passenger accommodation can be compared with any of the modern New York liners. The first class staterooms, which are situated amidships and extend over six decks, are particularly lofty and well ventilated. The dining room calls for special comment, introducing an entirely new feature in its construction; for while the saloon occupies the full breadth of the vessel, it is carried upwards through two decks, thus giving the passengers the impression that they are dining in a lofty banqueting hall on shore. Furthermore, there are a splendidly arranged smoking room, a drawing room, a dining room for children and a winter garden. In addition to this there is a large swimming bath, air and sun bath, gymnasium, hothouse, dark room for photographers, etc. Another provision conducive to the comfort of passengers is the introduction of anti-rolling tanks, which have been proved to practically eliminate rolling even in the most severe weather. Besides the first class accommodation there is an excellent second class, a second class A, and the steerage. The steamer left on her maiden voyage from Hamburg to the River Plate Nov. 20, 1911.

HAMBURG SOUTH AMERICAN LINER CAP FINISTERRE

Progress in Freight Handling

In referring to the progress in freight handling the *Engineering Record* comments on the handling of freight in the terminal of the Missouri, Kansas & Texas system at St. Louis. It says:

"From time to time the mechanical handling of freight has been strongly urged, but it was only recently, after Mr. H. McL. Harding took up and pushed the telpherage system of overhead conveyance, that mechanical handling of package freight was really given careful study. Perhaps one reason for the delay has been the rather unfortunate observation frequently made, particularly in Europe, where mechanical handling equipment is more extensively used than here, of the tendency to shirk labor where a machine is at hand. Anybody who has observed a couple of German crane hands, as husky as wine vats though far less interesting, attach the hook of a 6-ton traveling crane to a 100-pound package, and thus move it 20 feet, is not likely to be wildly enthusiastic over labor-saving machinery of this sort. First impressions are pretty strong, and so many transportation men have seen such accurrences in Europe and in England that a feeling of distrust of machinery as an aid to economy has arisen.

"In any case of self-evident possibilities for reform it is wise to get away from prejudice, and fortunately any freight official can now take a stop watch and see for himself what mechanical handling will do. At the time when Mr. Brandeis was telling the Inter-State Commerce Commission that railway operators knew nothing about economical methods of handling freight, the American railway world was watching with deep interest the construction of the freight terminal of the Missouri, Kansas & Texas system at St. Louis. Mechanical handling of the same sort had already been used successfully at one of the wharves of the Baltimore & Ohio Railroad, but there was not enough freight at that point to give it a real trial, and so the St. Louis experiment was regarded with deep interest. The terminal was put in service on June 1. The very first day the teamsters tried to block the station by delivering about 25 percent more freight than usual. It was all handled without a hitch. Since then the station has been doing better than was expected so early in its service.

Communications of Interest from Practical Marine Engineers

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs

Needless Faults in Engine Room Design

It is a pity that many engine designers have had little or no sea experience. If they had sea experience they could improve the layout of the engine room, simplify the general arrangment, and make a more simple, efficient and satisfactory pipe plan. The writer finds it of incalcuable value to take a trip to sea once in a while to study conditions and note changes and otherwise obtain useful information, and it would pay any designer of both hull and engine to do likewise.

While making some tests on the steamer M———, the writer was impressed by the utter lack of appreciation of the requirements of service conditions relating to water service. This ship was designed and built by one of the most famous yards in the country. The engine was a triple expansion and there were two Scotch boilers. On the starboard side and bolted to the aft bulkhead of the engine room was a manifold containing eight valves. Connected to this manifold was the water service connection. If by any chance whatsoever all valves were closed, the engine water service was out of commission.

One morning the writer was taking data on the 4 to 8 A. M. watch, and had just gone around the engine feeling the bearings and taking notes. After making the rounds, he by mere chance felt the No. 6 bearing again and found it warming up. In less time than it takes to tell it, the bearing became very warm, and in removing the oiler on the top of the bearing cap and reaching down the writer felt the shaft and found it hot. The cock on the main service pipe was open but there was no circulation of water. We were at the time off Winter Quarter Shoal Lightship. The deck was notified that we would be compelled to shut down for a few minutes, due to hot bearings. The cap was eased off and the writer jumped for the strainer box, which was about 4½ inches square, and was located next to the bulkhead on the port side of the engine room. Upon opening this strainer a small crab fish was taken from it, the strainer was cleaned and replaced, and the bonnet put on. Heavy oil was used for the rest of the run on bearing No. 6. After arriving in port the cap was removed and it was found that the metal had dragged. This, of course, meant scraping the bearing, and as the pins and main bearings worked on thirty-six leads it was some time before this bearing could be put to this lead.

Now the thing that presents itself is this: Why should a water service be connected to a manifold where, by the merest chance, all valves could be accidentally closed? Why put in a small strainer? Is it not as well to put a separate connection for water service with a large and ample strainer in the line? It would cost more, but this ship was delayed two hours and the work on the bearing meant that other work was delayed. A water service should be a separate and distinct system and should receive very careful consideration, especially when it is in service all the time for bearings and guides, as these were all water cooled. If this designer had been to sea, and had realized the importance of the subject, he would have planned a different arrangement. If a sea-going engineer who had known his business had been inspector the chances are that it would have been different.

There is another thing which many engineers have to contend with, and that is inaccessibility of auxiliaries. In this ship the circulating pump and the engine were so close to the bulkhead that one would have to run the risk of loosing an arm in trying to feel certain parts, and hence it was often taken for granted that it worked cool all over; in any case it was squirt oil all around and trust to luck that it found the hole. There was ample room to place this very important auxiliary in an accessible place, and doing so would have saved copper pipe, which in itself is an item. The donkey pump was placed on the upper grating, of course, on brackets or a foundation made up of plates and angles, but placed so close to the engine-room casing that to pack it without removing a panel of the casing was impossible.

Another very objectionable thing was the location of the expansion joint on the main steam pipe. The aft end of the boilers projected into the engine room, which is common practice and sometimes necessary, but the expansion joint was placed near the stop valve on one of the boilers, instead of between the boilers, as it might have been placed, as there was plenty of room between the pipe and the bulkhead or screen to enable a man to pack it. As it was, it was a most difficult job to pack, and in hot weather was a very undesirable job. If the man who designed it was made to pack this joint in southern latitudes, and in the month of July, as the writer did, I can assure him he would certainly have changed it.

Now why do these things occur? Simply because either the designers have never had sea experience or they do not stop to think. A general arrangement is only a general arrangement when it is good, and it is only good when it considers ways and means of simplifying the handling and maintenance of machinery at sea. Auxiliaries must receive a lot of attention and they will receive it only when they are accessible. They can usually be located properly during the design and building, although the average designer has an aversion to the practical engineer, but I have found that the very best results have been obtained when he has been consulted. The practical engineer may not be able to compute the design or delineate it, but he can give his ideas, which, from practical experience, are worthy of great consideration, and the writer has found that the criticism of his designs by practical engineers, as well as his own experience at sea, has simplified and improved design with a corresponding increase of efficiency and satisfaction. And I further say that there are ships to-day which can be made very efficient by changes which would pay for themselves in a very short time, and if the present engineer is not capable of handling it satisfactorily there are plenty who are and not only anxious to improve conditions for themselves but to show the owner returns.

Charles S. Linch.

Some Notes on the Breaking of Shafting

The following notes are an attempt to offer a reasonable explanation of the breaking of tail shafts and propeller shafts which occurs so frequently and for which it is sometimes difficult to put forward reasons. It is not the intention of the writer to convey the idea that the suggestions given solve the problem, but rather that marine engineers and those interested in marine engines may be assisted in forming conclusions upon which they may base their remedy.

A curious property of broken shafts is that they are often

highly magnetic, and if the reader, at the first opportunity, tests a broken shaft with a compass needle he will be able to verify the statement. It is not, however, remarkable that a mass of steel should have an effect on a magnetic needle, but it is found that the broken faces of the shafting show *like* polarity. If we take an ordinary bar magnet, say a magnetized knitting needle, for example, and break it into three pieces, we will find that we have three magnets each with a north and each with a south pole. But we never find, when we have broken the magnet, that the two adjacent faces of fracture have the same polarity. Thus, although the shaft is magnetized, its magnetism, or, if we may say so, the disposition of the molecules, differs from our usual experience of magnetized bodies. It has been stated that shafts have been found in such a condition that they were magnetic enough to support spanners, bolts, etc., and that if a handful of rivets were thrown at the shaft many would stick to it. Shafts as highly magnetized as this, however, do not appear to be common, although in almost every case distinct polarity can be detected.

A curious point in connection with this is that nearly 80 percent of the failures of shafting take place in the Atlantic trade. The fact of the prevalence of heavy weather in this trade, and that ships often run out light accounts for some of this, but is it not possible, applying our theory, that as the ship is running east or west, and therefore her shafting cutting the earth's lines of force just like the armature of a dynamo, the effect the currents produced may show itself in the molecular disturbance of the metal. Should this be the case, an effectual remedy would be a coil of wire, not necessarily a large one, through which a current was passing round the shaft. Such would have the effect of keeping the polarity of the shaft constant. The only reason that the writer offers for this peculiar relation between magnetized metal and weakness is that the magnetism has an effect on the molecular structure which may be something akin to fatigue. It is not necessary that such magnetism as a shaft may possess be acquired when in use. It is found that if a shaft is forged lying in a north or south direction it has a strongly marked polarity. Such may explain the magnetic condition of steam hammer piston rods which so often break. In forging, shafts are often fractured through insufficient heating during the process. When the outside of the shaft is hammered and thus stretched the inner portion is stressed and sometimes this stress is sufficient to cause actual fracture. Unfortunately such fracture is invisible and the outside appearance of the shaft gives no indication of its presence. This form of weakness in shafting is often brought about by lengthening shafting. In these days, when so many ships are built after the same model, it is the practice for ship engineers to stock shafting and, in lengthening a portion which they have in stock, insufficient heating during the process often causes serious internal stresses.

In one case, some time ago now, it was found that a ship was constantly breaking her propeller shaft and with a view to strengthening the diameter was increased. Curious as it may seem, this did not improve matters, but rather made them worse. The reason was not evident, but yet was not complicated when discovered. In this instance the ship was weak and in a seaway was liable to bend. As the shaft had to bend with the ship the larger it was made the more liable it became to fracture. This is plain when we remember that the strength of a shaft in torsion varies as the cube of the diameter, while its longitudinal rigidity varies as the fourth power of the diameter. Any increase, within practical limits, will not prevent the ship from bending, and, since the shaft must bend with her, the stress on it will be increased.

An interesting case is one where a dynamo used for ship lighting broke the shaft with persistent regularity. The dynamo was placed athwartships and in bad weather the engineers were accustomed to look to it for trouble. It was suggested that the machine should be shifted so that its shaft lay in a fore and aft direction, and on carrying out this suggestion the trouble was removed. The explanation was that the armature of the dynamo, running at high speed and having considerable momentum, acted as a gyroscope. The principle of the gyroscope is that a wheel, revolving at high speed in a given plane, tends to remain in that plane and resists any force which is applied to alter the plane of rotation. This resistance takes the form of a force at right angles to the applied force. In the above case the applied force was the rolling of the ship and the reaction was sufficient to break the shaft of the dynamo. By placing the axis of rotation at right angles, as it were, to the direction of the applied force the effect was eliminated.

The foregoing notes may be sufficient to show that the reasons for many bewildering troubles the marine engineer is confronted with are hard to find, yet interesting when found. Some of the theories given may be considered too imaginative, but imagination is necessary in solving all problems. Above all, what is more necessary than imagination, is reasoning, and marine engineers must learn to look farther than common reasons for uncommon results. In this a small amount of technical knowledge often counts for more than years of experience, and, what is more, leads to an understanding of the principles, which underlies the cause and the effect.

I. R. Thomas.

Newcastle-on-Tyne.

Milling the Links of a Stephenson Valve Gear

During the slack season, when orders were few and far between and machinery depreciating, more rapidly, through lack of employment, we determined to launch out in a new field, in which there seemed to be an opening, to at least keep our staff employed until trade brightened up.

Our factory was situated close to the shipping quarter, but as business in our own line had hitherto been brisk little attention was paid to that fairly remunerative line, ship repairing, so, to hustle things up, we made bids for all sorts of jobs in that direction, and one of the first to turn up nearly floored us, as there was no machine tool in the factory capable of taking the job, namely, "truing" up the links of a Stephenson value gear with a radius of fourteen feet. However, as our motto is, "Ever onward," the bid was taken and brains puzzled how to do it when our foreman hit upon the idea that carried us through in good style.

Near one of the planers was the foundation of a drill press, which had been moved to a more convenient position, so this was utilized as a center on which to erect a table to carry the hub and radial arms of our design to effect the work on hand.

A piece of steel shafting was cast into a block of iron and the whole thing squared up in the lathe. On the base of the cast-iron block four bolt holes were cored to centers to correspond with T slots in the table erected on the old site of the drill press. The whole thing was then set up to the center line of the planer, an old pillow block was found to fit the steel pin, to which we built up two arms of channel iron to a radius of fourteen feet, measured from the center of the pin to the center line of the links.

The links were leveled up on two smooth blocks of cast iron and squared to the surface of the planer table; then the radial arms and center piece were squared to the links as they lay on the planer. When all had been set up fair and true the bolts were drawn up tight and the whole thing made fast, so that it resembled the segment of a flywheel. A milling attachment was rigged up on the tool post of the planer

and set to take a 1/32-inch cut, which was all that was necessary to true the face on that side.

To find feed motion a piece of a gear wheel was cut out and pinned on to the radial arms. This was geared to a lathe train of wheels to give a feed speed of about ¼ inch per revolution of the milling cutter, as we were anxious to avoid chattering, which would probably have set up at a high speed, owing to the long reach and the insecurity of the fixture.

The whole thing was run over and the cutter started with the feed gear in motion. Everything worked smoothly. When the top was finished a packing piece was added to the back of the milling attachment to bring it out to the inner radius and set to skin the metal, as it was not so far out as the outer radius.

We had the satisfaction of turning out a good job, while the arrangements ate up most of the profit. There was a margin left which justified us in accepting the overhaul, as since then we have had occasion to use the rig on similar jobs.

Dundee, N. B. C. F. M.

Broken-Down Circulating Pump

On one steamer where I was engineer we had an independent circulating pump for each engine, situated on each side of the engine room, the port pump for the port engine and the starboard one for the other side.

They were centrifugal pumps, and the vane shaft was in line with, and connected to, the shaft of a single cylinder, vertical, engine, twelve-inch stroke. It is necessary to tell the foregoing as it is with the engine that the breakdown occurred, and as the pump could be operated only by the engine a breakdown one way or the other shut that unit off altogether. To counterbalance this state of affairs there was a by-pass valve on the discharge side of the harbor gynne, whereby water could be pumped through the main condenser by this small pump, instead of through the harbor condenser, on the starboard side, and a discharge from a donkey pump on the port side.

Everything had been going well on this trip until one morning, just before relief of the twelve-to-four watch, the starboard engine slowed up, and a glance at the gages showed the vacuum gage quickly approaching the zero mark.

Steam coming from the starboard side of the engine room brought the senior engineer of the watch around to that point, when he found the starboard pump stopped. The relief engineers, coming on watch at this time, tried to get the engine going, but with no success. The starboard engine had been almost stopped by this time, word being sent up to the bridge to that effect, and progress being made "on one leg." The broken pump was shut off, and the harbor pump, the connections of which I described above, was started. Being a much smaller circulating pump than the broken main unit, it was able to hold anything like a vacuum only when the starboard engine was going slowly, due to the impossibility for it to condense such a large volume of steam, passed through on full speed.

A hurried feel around the pump and engine disclosed no overheated bearings or parts, so we again tried to lever the crank wheel over, but she would not "go over" the bottom center, although there was no obstruction in the crank pit. The engine would go round each way until it came to about an eighth of the crank circle radius on the bottom, when nothing would fetch it over, so it had to be opened up.

The cylinder cover was removed, as also was the piston, when the neck bush was found in a dozen pieces. The piston and crosshead had to be taken out through the bottom cover as it was all one forged piece, and a search was made for the spare neck bush, with no result, however, as the one which had just given out had been renewed only a short time before, and a spare neck bush had not as yet been shipped on board. The neck bush had a collar on the stuffing-box end, and this collar must have been broken off or the bush could never have found its way into the cylinder. I take it that the gland may have been allowed to remain unscrewed a little and that the bush was a trifle slack in the bottom head and the whole packing resting on the top of the gland allowed a certain free up and down movement of the bush with the present result: One turn of the engine would bring the neck bush into the cylinder, as it was a split one on account of the shape of the rod, and the two halves falling apart brought the engine to a stop on its bottom center but with a disastrous effect to the bush. There was no apparent effect on any other part of the engine, and this was due to the fact that this class of pump does not require a very great speed to lift the circulating water in quantity.

A repair had to be made and soon; but as we did not have a spare bush on board we fixed it up this way. Two washers were made out of ⅛-inch iron, the diameter a little more than the stuffing-box, and a hole the diameter of the piston rod. When these were fashioned we cut them across the centers, splitting them. We now filed them to fit the rod and stuffing-box and put the first on in the box just a nice snug fit with the split fore and aft. The next washer was put in, split on the square of the other, athwartship. This made a good solid bottom for the packing, which consisted of a hard bottom turn and a filling of the usual kind. The longest job was taking the engine apart and making these washers. It did not take long to reassemble the parts together again, and I think you can guess the job was a good one and the only kick I had was because the circulating pump should have given out when we were on the hottest period of our journey in July.. H. W. H.

International Safety Congress

The new American idea of the Safety Engineer, an accident prevention specialist, will be brought to the notice of world industrialists at an International Safety Congress to be held in Milan, Italy, for five days, beginning May 27, 1912. This Congress, the first of its kind of international scope ever held, will be for the purpose of setting in motion a world-wide movement for the conservation of human life in industry. The American Museum of Safety, 29 West Thirty-ninth street, New York, is making preparations so that the United States will be well represented. An American National Committee has been selected by the American Museum to co-operate with the International body and to promote the American ideas and views at the Congress. Dr. W. H. Tolman, director of the American Museum of Safety, and other members of the committee will attend the Congress.

The following are some of the papers which will be read at the Milan Congress:

"The Safety Engineer on a Large Transportation System," by Dr. W. H. Tolman, chairman, American National Committee.

"How the New York Edison Safeguards the Lives and Limbs of Its Employees," by Arthur Williams.

"The Work of the Safety Committee of the United States Steel Corporation."

"Safeguarding the Traveling Public and Protecting the Employees of the Electric Street Railway Association."

"Proper Illumination and Accident Prevention," by J. V. Lansingh, president of the Illuminating Engineering Society.

The Bureau of Navigation reports 68 vessels of 2,388 gross tons were built in the United States and officially numbered during the month of January. This included only one steel steamer, the gross tonnage of which was 125.

Review of Important Marine Articles in the Engineering Press

The German Submarine U 8.—According to Jane's "Fighting Ships" the U class of submarines for the German navy are divided into three classes—U 1 by itself, U 2, 3 and 4 and U 5 to U 12, inclusive. U 1 is reported to have a displacement of 180 tons and a four-cylinder petrol engine, which drives on the surface at 12 knots and 9 knots submerged. The boat is said to have a length of 128 feet and 9-foot beam. Of this craft little more is known and of the others practically nothing. It is apparent, however, that this boat has acquitted herself well, for announcement has been made of special honors given her commander and chief engineer by the Emperor. With the article are four photographs of the vessel carrying out evolutions at the surface. 360 words.—*The Engineer,* December 1.

The French Destroyer Bouclier.—Principal dimensions: Length over all, 233 feet 4 inches; length between perpendiculars, 230 feet 4 inches; extreme breadth, 24 feet 10 inches; depth, 16 feet 5 inches; mean draft, 12 feet 6 inches; displacement on trial, 660 tons. The hull is of high tensile steel, divided into ten watertight compartments. The freeboard forward is high, giving navigating officer good protection and enabling speed to be maintained in a rough sea. There are four Normand watertube boilers, burning oil. Working pressure is 228 pounds per square inch. Main engines are turbines, of the Parsons type, driving three shafts. Propellers are 5 feet 3 inches diameter, 4 feet 11 inches pitch, designed for 1,000 revolutions at full speed. The mean speed for six hours was 35.3 knots. Shaft horsepower for this trial 15,000. Bunker capacity is provided to give steaming radius at 14 knots of 1,950 miles. 1,100 words and photograph.—*The Engineer,* December 15.

Suction Dredge New Orleans.—There is being built for the Engineer Corps of the War Department by the Fore River Shipbuilding Company, at Quincy, Mass., a twin-screw suction dredge of the Fruhling type for service in the southwest pass of the Mississippi River. The head of the dredge is a large, enclosed rake, about 18 feet wide by 5 feet fore and aft, with sharp-cutting teeth, through which is injected water under high-pressure, thereby helping to disintegrate the soils and make it of suitable consistency to be readily sucked through the duplicate suction pipes. There are ten hoppers, with a combined capacity of 3,027 cubic yards, or 3,000 tons, which can be filled under favorable conditions in thirty minutes. The machinery consists of four sets of triple-expansion engines, arranged in pairs, tandem, and built on common bed-plates. The two after sets are commonly used for propulsion and the two forward sets for pumping, although the four sets may be coupled together for use in propulsion. Steam is generated by Babcock & Wilcox boilers. Material may be dumped through bottoms of hoppers or pumped overboard through a swivel discharging pipe for reclamation work, or into scows or other hoppers alongside. Principal dimensions are: Length over all, 315 feet; length between perpendiculars, 300 feet; breadth, molded, 50 feet; depth, molded, 26 feet; dredging depth, 21 to 50 feet; draft, loaded, 20 feet; speed, loaded, 10 knots. 950 words and photographs.—*Marine Review,* December.

The Austrian Battleship Zrinyi.—The greater part of this article deals with the present status of Austria as a sea power and how this country is coming to the notice of the nations. The battleship *Zrinyi* is one of the three latest to be built, the others of the class being named *Erzherzog Franz Ferdinand* and *Radetzky.* These vessels have unusually large armaments for their displacements, due to the milder weather conditions of the Mediterranean and Adriatic seas as compared with the rigors of the Atlantic, which must be taken into consideration by the designers of the first powers. Thus battleships in this rating belonging to the other navies have a knot or more speed and greater coal-carrying capacity. The principal dimensions for this ship are: Length, waterline, 448 feet; length over all, 456 feet; beam, 82 feet; mean draft, 26½ feet; displacement, 14,268 tons. The machinery consists of two sets of triple-expansion engines, designed for 20,000 horsepower and speed of 20 knots. Actual trial developed 20,600 horsepower and a speed of 20.76 knots. All three ships were built and engined by the Stabilimento Tecnico, Trieste, and completed between 1910 and 1911. 1,300 words with photograph, diagram and table of comparison.—*The Marine Engineer and Naval Architect,* December.

The Danish Torpedo Boat Soridderen.—One of the latest additions to the Royal Danish navy and designed especially for the shallow waters near that coast line. The vessel was built by Messrs. Yarrow & Company, and has the following principal characteristics: Length, 181 feet 9 inches; beam, 18 feet; two Yarrow watertube boilers built for a working pressure of 265 pounds per square inch, working Brown-Curtis turbines on two shafts. Each turbine casing has an astern turbine, thus facilitating maneuvering. In the official trials, in rough water, a mean speed of 28.28 knots was obtained with 5,300 shaft horsepower at 1,050 revolutions per minute. The consumption trial showed the vessel to have a radius of action of 1,400 miles at 14 knots speed. The article is accompanied by two page plates, showing general arrangements. 850 words.—*Engineering,* January 26.

The Armament and Protection of Battleships.—By the Hon. Salvatore Orlando, President, Italian Institute of Naval Architects. The author first outlines a number of advantages to be considered due to tactical reasons. Then follows the description of a design of a vessel which carries out these and other desirable principles. A point considered was advantageous arc of fire and best placing of batteries to secure it. Secondly, and at greater length, he considers the defense of the ship below the water-line. Recent experience has shown that under-water explosions are more dangerous horizontally and downward than upward, and that excessive forces diminish rapidly with distance from their center of action. It is urged that protection against such attack be placed as near amidships as may be, the side of the ship having little real armor. This, with the reducing in size of all watertight compartments, is considered the most effective means of safety in time of disaster. Triple bottoms are not considered desirable enough to warrant the increased height of the ship produced. The vessel's stability under damaged conditions is shown by drawings and by results of stability calculations. The principal dimensions of the ship designed as an example are: Length between perpendiculars, 512 feet; extreme beam, 91 feet; draft, 26 feet; metacentric height, 23 feet; speed, 24.3 knots; main battery, eight 13.5-inch guns. Propelling machinery consists of turbines on three shafts. Boilers are in three groups, each with its own funnel. Bunker capacity is 2,000 tons of coal with tanks for 600 tons of fuel oil in the double bottom. Illustrated with drawings. 2,600 words.—*Engineering,* January 12.

Depth of Water on Measured Mile.—A valuable contribution on the subject, containing practical rules whereby navigators may know when their ships are in waters of uneconomical depths. Contains a synopsis of several previous articles giving results of trials of ships on different measured miles with widely varying results. Well-known examples are those of the United States battleship *Michigan* and the tor-

pedo boat destroyers *Flusser* and *Reid* on the Delaware Breakwater, Provincetown and Rockland courses, trials of the British torpedo boat destroyers of the river class, and later of the *Tribal* class on different courses near the English coast. Additional information is furnished by extracts from a paper by Prof. H. C. Sadler on "The Resistance of Some Merchant Ship Types in Shallow Water," read before the Society of Naval Architects and Marine Engineers last November. The article contains plots of horsepower to base speed of ships similarly loaded on different courses and formulæ for computing favorable depths of water. 3,000 words.—*The Engineer,* January 26.

The Hydraulic Interaction Between Passing Vessels, Called Suction.—By Sidney A. Reeve, M. E. An investigation from the viewpoint of a consulting engineer of the court records available of collisions of vessels due to suction. Some of the later instances are familiar to those who have followed marine history for some years. The causes of these phenomena are then explained by reference to certain well-known principles of hydraulics, a simple illustration of which is found in the Venturi meter. From these theories, the author takes facts gathered from a recent example of the action of suction between vessels (and plots wave diagrams). From these he shows analytically why the vessels in question collided and why these two examples were especially susceptible to danger. These results are then compared with those of Naval Constructor D. W. Taylor, whose experiments were conducted in the government tank and whose results were presented to the Society of Naval Architects and Marine Engineers in 1909. The work agrees in substance with the theories outlined by the author. No results are given to show how near passing vessels may approach each other without danger. 9,500 words with diagrams.—*U. S. Naval Institute,* December.

Development of the Marine Boiler in the Last Quarter Century.—By George W. Melville, Rear Admiral, U. S. N., Retired. A careful review of the author's efforts toward the adoption of watertube boilers in the United States navy. At the time the author began his work as engineer-in-chief the watertube boiler was not used in the navy. Its adoption in a few instances in very small vessels was not considered conclusive proof of its desirability for large ships. With much effort a trial was arranged, and watertube boilers were installed in the *Monterey* and *Cushing.* Since that time its use has grown rapidly until now practically all naval vessels are so equipped. The author names the following characteristics of any thoroughly satisfactory watertube boiler: Reasonable lightness, with scantlings sufficient to promise reasonable longevity; an adequate amount of water, so that failure of the feed supply or any inattention thereto would not immediately cause trouble; accessibility for cleaning and repairs on both water and fire sides; straight tubes, with no screwed joints; no cast metal, either iron or steel, subjected to pressure; ability to raise steam quickly; high economy of evaporation; economy of space; interchangeability of parts, and, as far as possible, the use of regular commercial sizes for facility of repairs; the ability to stand severe forcing without injury; the ability to stand abuse, of rugged construction, and not so delicate as to require skilled mechanics to run it; safety against explosion, meaning that only the part of the boiler which gave way would be damaged. Several types have been found that satisfactorily fill these conditions, with the result that naval boiler plants are high in efficiency and capacity. The author expresses surprise that the watertube boiler is not much more used in merchant practice, where so large an item in weight might be saved. The article is accompanied by tables of tests on both watertube and cylindrical boilers, giving much valuable data for design and operation. 5,700 words.—*The Engineering Magazine,* January.

Some Impressions of Continental Marine Diesel Engine Practice, No. 4.—It may be hard to become enthusiastic about the status of oil engines for marine purposes in a country where little has actually been done, but when visiting in the shops in countries where literally dozens of engines of this type are being built and installed in various craft, from submarines to cruisers, it is more easily realized that the internal-combustion engine for use of heavy oils is beginning to come into its own, and that soon. The author of this article shows what is being done in two shops on the Continent, and makes general comparisons with work in others. He describes in some detail the Sabathé motor, which recently passed through the Admiralty tests of ten hours' duration with the remarkable fuel consumption of 0.38 pound per horsepower-hour. He also takes up the work of Scheider & Company, of Le Creusot, and describes an 8-cylinder, 4-cycle engine for submarines, which turns at 400 revolutions per minute and weighs about 67 pounds per horsepower. He sums up the situation for European builders by giving the following achievements: 6,000 horsepower on one shaft, 2,000 horsepower in one cylinder, 1,250 horsepower already running, and 1,000-horsepower engines almost a common thing. 3,600 words.—*The Engineer,* December 29.

Propeller Erosion.—An account of the metallurgical difficulties experienced in service with high-speed turbine propellers. Formerly some similar actions were reported on wheels driven by reciprocating engines, but these were overcome by substituting bronze for steel. In this article a detailed account is given of the finding of a new metal which is not affected by the serious conditions at present encountered. The work was undertaken by Dr. O. Silbarrad, of the Silbarrad Research Laboratories, Buckhurst Hill, Essex, who had already carried out some similar work for the Admiralty. Although at first the research was not encouraging, an alloy was found after an enormous number of specimens had been tested which has proved satisfactory. The name Turbadium has been given this, and it has been used on the *Mauretania* for six months' continuous service without showing signs of erosion. It is stated that orders have been filled for large propellers for foreign navies as well as for the British Admiralty. The article is well illustrated by photographs of propellers showing erosion. 2,500 words.—*Engineering,* January 12.

The Internal-Combustion Engine at Sea.—An editorial discussion of the gas and oil-engine in large sizes for marine purposes and ways of making them more practicable for such use. "We are, no doubt, still far from the realization of the long-standing prophecy that the steam engine is to be ultimately relegated to the museum of mechanical curiosities; but so far as high-speed launches are concerned the victory of the internal-combustion engine is hardly disputable, and debate now centers on its suitability for larger craft. With existing types of motor, however, it seems hardly probable that much success will attend the system where really large powers are required on a moderate displacement." Following this is a comparison of weights of machinery installations for both systems, in which the internal-combustion engine compares very favorably with the average large-size commercial steam marine plant, but quite the reverse when compared with high-powered, high-speed craft, as in torpedo boat destroyers. Under the subject of fuel, the oil engine is given the preference. It is suggested that this solution might not long hold if oil fuel became in general demand. The attendant rise in prices might overcome whatever advantage now lies in its cheapness. At present the mechanical features of the internal-combustion engine are against it. "Hitherto the problem has been attacked mainly by 'erudition' rather than by 'invention.' The Diesel engine and the large gas-engine are essentially the productions of men who have been taught to apply theoretical

principles to the ordered development and improvement of previously existing types of prime mover. It is, however, most probable that the ultimate solution of the marine gas-engine will be found in some entirely different direction of development, since it is difficult to see any possibility of substantial further improvements along the paths hitherto chosen, the possibilities of which have been pretty exhaustively exploited." 2,000 words.—*Engineering,* January 12.

The Diesel Marine Engine.—By Herr Th. Saiuberlich. The last of a serial on this subject. The first part of this instalment speaks of the cast parts from the founders' point of view, and describes mechanical features of the motor. Towards the end practical comparisons are made between performances of the Diesel motors and steam plants, especially in the cases of the North Sea fishing boats, where many of these engines are used with economic results. It is claimed that their introduction will mean much toward the up-building of the German herring fisheries. An example of increased economy by the adoption of this engine was in a fishing boat which can now carry 160 casks of herring more than before and go 1½ knots faster. Several illustrations of mechanical details. 4,000 words.—*The Steamship,* November.

The Carels Diesel Marine Engine.—A brief description of a recent two-cycle, four-cylinder engine built by this well-known firm at Ghent. The engine is single-acting, and is capable of burning the heaviest oils on an economical consumption. The structure of the engine is similar to an ordinary marine steam engine and calls for no comment. The cylinder heads contain valves for fuel and air inlet and also scavenging valves, of which there are four for each cover. Compressed air is supplied by a three-stage compressor worked by the main shaft forward. All essential control gearing is interlocked, making them impossible to operate in any but the correct sequence when stopping or reversing. 1,000 words, illustrated.—*Engineering,* January 19.

A Thirty-Day Non-Stop Run of a Marine Oil Engine.—The principal objection to marine oil engines of any size has always been non-reliability. It might be hard to prescribe a test that would prove the presence of reliability of working in any engine, but in any case such a run as was recently made in the shop of Barclay, Curle & Company shows that the engine under trial could run satisfactorily much longer than any sea trip would require. Recently this company built a single-cylinder model of an engine to be built for the *Jutlandia,* and tested it with a thirty-day non-stop run. The size of the cylinder was 22 inches diameter and the stroke 29¼ inches. The engines for the ship mentioned are to be eight-cylindered, and are designed to give 1,250 horsepower. Careful records during the test showed the consumption to be 0.45 pound per brake horsepower, and the maximum horsepower 126 at 143 revolutions per minute. The cylinders and rings were in very good condition after the run, and gave no indication of being unable to continue the test. 2,500 words.—*The Engineer,* January 26.

Cylinder Condensation.—An editorial discussion of a paper on this subject by Prof. Mallanby, D. Sc., read before the Institution of Engineers and Shipbuilders in Scotland on Nov. 21. The whole subject is one of primary importance to steam engineers, and has to do with the discovery of the missing quantity of steam in an engine cylinder. Three possibilities are open: First, that Regnault's steam tables are wrong; second, steam may leak through the engine; third, condensation may be much higher than is generally supposed. This latter possibility is the one favored by the editors, and their contention is based upon the claim that condensation depends upon temperature of the cylinder walls at the instant of admission, and not on average temperature of the metal of the cylinder for the whole cycle. The manner of heat transmission intermittently to and from walls is not known, neither are the accurate temperatures of the surfaces involved—and even less, the volumes and temperatures of clearance spaces. With this data missing little definite can be known. 2,400 words.—*The Engineer,* January 19.

Latest Development in Condensing Systems.—By J. B. Howell, U. S. N. A study of fundamental conditions met with in condensing systems followed by examination of three systems in present use to best meet requirements of present-day usage. First, the Dual air-pump system, developed by G. and J. Weir Company. This consists essentially of a wet air pump working at a temperature due to the vacuum in combination with a dry-air pump working at a much lower temperature. The other two are developed by Mr. D. B. Morison and are known as the Kinetic Rotary Air-Pump System and the Bi-Therm Air-Pump System. The former consists of a steam jet, followed by a special system of water jets to remove air and non-condensible gases, while the latter is a compromise between the dual and the kinetic systems and may be installed with present designs. In the article diagrams and drawings explain the action as well as the purpose of each type, and although not lengthy is clear and a suitable exposition of the subject. 4,700 words.—*U. S. Naval Institute,* December.

The Evolution of Lead-Lined Piping on Shipboard.—By R. D. Gatewood, U. S. N. First analyzes the results of galvanic action of sea water in pipes and states known means of preventing. Then gives the results of numerous tests by the Bureau of Construction and Repair as to the best means to adopt. Lead-lined piping has proved very satisfactory on trial aboard several ships. The author then describes method of making, and tests of the pipe made before using. It is claimed that this piping weighs 5 percent less and costs 50 percent less than the same installation of copper piping. Gives a list of points well known from experience with this method and cautions to be observed in its making. 7,000 words.—*U. S. Naval Institute,* December.

Engineering Works at the Rosyth Naval Dockyard.—The first instalment of a series of articles describing in detail the construction of the new naval dockyard authorized by Parliament and begun in 1909. The situation is on the Firth of Forth, and the land purchased for the site is 1,200 acres in extent. The contractors for the work are Messrs. Easton Gibb & Son., Ltd., and the progress they have made already speaks well for the early completion of the work. After dealing with the geological conditions of the work and showing its general scheme, the author describes in detail the contractor's organization and provision for the workers. Other topics covered are the temporary dams built, the concrete-mixing plant and the building of the walls. The article is accompanied by numerous illustrations and drawings which show the arrangement and progress of the work. 11,500 words.—*Engineering,* January 19.

Recent Progress in Warships and Machinery.—An editorial review of the shipbuilding progress of Great Britain during the year 1911, especially in the particular of new warships added to the navy. It is argued that the number and power of warships launched in a year is a good index of the provisions made to conserve sea supremacy of that nation. A careful list is given of the ships and class, where built and general characteristics as to power, speed, armament and armor. A table is included showing results of all steam trials made during the year in the navy. Mention is also made of the warships built in England for foreign powers. 5,000 words.—*Engineering,* December 29.

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This issue of International Marine Engineering marks the fifteenth anniversary of its publication. Originally the magazine was published in New York under the name of Marine Engineering, but for the last six years an English edition has been published in London coincident with the American edition, and the name of the magazine has been changed to International Marine Engineering. The policy of the magazine, however, has remained unchanged, for it has always been our purpose to place before our readers in a clear and concise form all matters of importance relating to the engineering problems of maritime commerce and shipbuilding irrespective of nationality. It is with pleasure, therefore, that we take this opportunity of expressing our thanks for the extensive patronage accorded to both our editorial and advertising departments, which has made possible our work in this direction.

No period of fifteen years has been so productive of far-reaching developments and progress in shipbuilding and marine engineering as the fifteen years just passed. At the beginning of this period one of the greatest triumphs in engineering skill had been attained in the creation of the express steamer, a type of ship which was destined to decide the supremacy of the seas, culminating in such splendid achievements as the *Lusitania* and *Mauretania*. Greater ships have been built, and are now under construction; but whether the present limit of speed in passenger steamers will be exceeded depends entirely upon future commercial and contingent conditions. Such a step is entirely feasible from the standpoint of the naval architect and marine engineer, at whose disposal are the steady and logical developments of engineering and industrial arts; but the question of whether or not the financial returns from the future progress of maritime commerce will permit the enormous expenditures entailed with the increase in speed can only be decided in the course of time. The present tendency in the construction of passenger ships is towards a greater number of large-sized vessels of moderate speed with large cargo-carrying capacity. With this there is also a tendency toward more general use of the intermediate type of ships, which are in reality fast freight ships with limited passenger accommodations. The question of size depends upon the harbor facilities and depth of approach channels, the deepening of which beyond present limits seems at present to be too costly. Another important item, which, so far, has received scant attention, is the improvement of freight-handling facilities at terminals to reduce the cost and expedite marine transportation. With interest awakened in this direction, the general conditions of over-sea trade will be fundamentally improved.

The rapid progress in marine engineering during recent years has been influenced chiefly by the questions of speed and economy. In merchant ships of moderate speed the long-established types of Scotch boilers and reciprocating engines have maintained their superiority, although they have been subjected to continual improvement in the perfection of details and the elimination of imperfections. As a result, this type of propelling machinery has reached a state of perfection beyond which, with the present resources of materials and methods of manufacturing, there does not seem to be much opportunity for greater improvement. On the other hand, the value of speed and the necessity of obtaining as good, if not better, economy with propelling machinery for high-speed vessels, such as express steamers and naval vessels, where minimum weights and other limiting conditions are imperative, have opened up a wider field for development in marine engineering in the last fifteen years than ever before. Oil fuel, watertube boilers, turbine machinery and the performance of high-speed propellers, together with the more recent developments of internal-combustion engines, have afforded an immense field for investigation and development by the highest engineering skill, so that better economical results can be obtained under the various conditions that must be met. As the present period is largely one of transition and elimination, the present tendencies in marine engineering do not warrant definite conclusions as to immediate future developments, although the greatest possibilities lie in the use of heavy oil internal combustion engines.

Improved Engineering Specialties for the Marine Field

A New Marine Watertube Boiler

The watertube marine boiler shown in the accompanying illustrations, is an entire departure from the generally accepted type of marine boiler, as the numerous headers and expanded nipple connections usually used are eliminated. There are absolutely no joints or connections except the ends of the generating tubes, which are expanded into the water legs or flitches.

These boilers are built by the Charles Ward Engineering Works, Charleston, W. Va., in two types and of varying sizes to meet requirements. Fig. 1 shows a boiler which is particularly adapted for vessels of limited height between decks and moderate forced draft. The steam and water drum is located over the front flitch and at the lower end of the tubes. Circulation is provided by large openings in the bottom of the drum, registering with the rectangular passages in the water legs, delivering an ample supply of water to the generating tubes. The return from the upper flitch to the drum is through the top row of four-inch tubes.

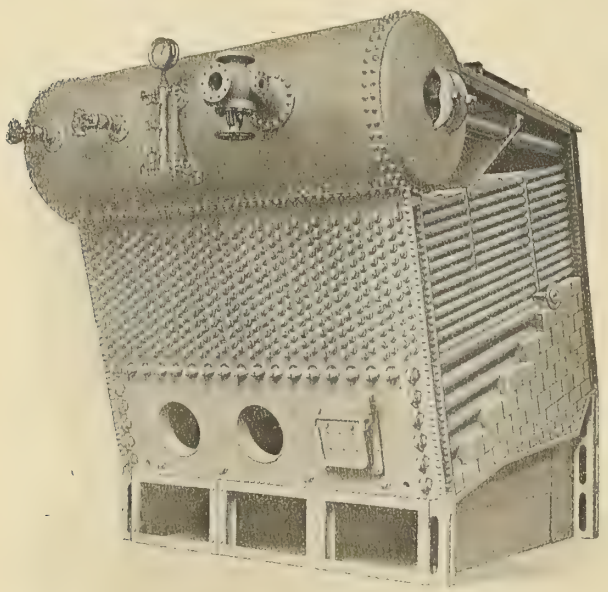

FIG. 1

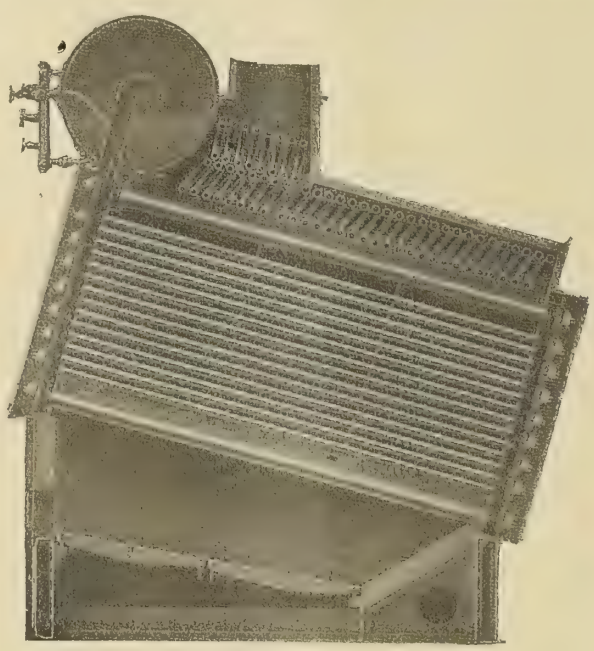

FIG. 2

The boiler shown in Fig. 2 has much larger passages for the circulation, and is designed for forced or natural draft and the greatest economy, having a superheater and a feed water heater. In this boiler the drum is in the front on the high side; the upper portion of the front flitch is enlarged where it is riveted to the drum; this chamber is divided by a diaphragm into two parts, one of them forming a passage from the drum to the large down-flow tubes, the other receiving the ends of the generating tubes, thus completing the circulation and delivering above the water line in the drum.

The water legs, or flitches, are constructed of steel plates, ¾ inch in thickness, forming the tube and hand-hole sheets. These sheets are spaced about 3½ inches apart, stayed to each other by improved and patented continuous stays, dividing the water leg into a number of rectangular passages, as shown in Figs. 3 and 4. T-shaped retaining grooves are milled in the tube and hand-hole plates approximately 6 inches from center to center. In these retaining grooves are fitted, in sections, a continuous I-section stay plate connecting the two sheets, thus forming the rectangular passages. This construction is claimed to be much stronger than any other method of supporting flat surfaces, as the connection is practically a continuous line, and the load per inch of stay is equal to the distance from center to center of the stays, multiplied by the working pressure, or only 1,800 pounds per lineal inch of stay for 300 pounds of steam, compared with 10,800 pounds per stay for the usual method of staybolting on 6-inch centers. Expansion and contraction is provided for by the flexibility of the stay plates, and the movement of the sectional stay in the retaining grooves. The troublesome question of leaky and broken staybolts is entirely eliminated, as there are no screwed or riveted stays in the boiler and no holes through the plates.

Each header, or flitch, in the moderate sizes, is constructed of one plate, folded through the center (Fig. 2), the edges channeled, flanged, or lapped and riveted, eliminating, as far as possible, all riveted joints, except the connections to the steam drum, which are flanged and riveted. Hand-holes covering a group of tubes, or individual plugs opposite each tube, give access for cleaning and renewals.

The steam and water drum is of large proportions, giving ample steam space and a steady water line. It is composed of one sheet, the joint being a very heavy butt strap, which insures the necessary strength where the drum connects with the front flitch, as large passages for circulation are provided at this point. The drum heads are bumped and fitted with a manhole at each end. The butt joints and heads are double riveted, all rivet holes drilled in place after the work is fitted, insuring fair holes and tight work.

The generating tubes are 2 inches outside diameter of extra heavy gage. The length is varied as required, depending on conditions. The down-flow tubes are 4½ inches outside diameter and No. 6 B. W. G. All tubes are expanded into the tube plates and the ends flared.

Feed water heaters and superheaters are furnished for either design when desired. As shown in Fig. 2, the feed water heater, located in the up-take, is of the long flow type, and consists of three headers with U-shaped tubes, the open ends expanded into the headers; the water entering the top header,

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travels through the tubes full width of the boiler four times, and is finally conducted by the internal feed pipe to the bottom of the drum, discharging through jets into the down-flow passage of the front flitch, thus increasing the circulation. The superheater is of the same general construction as the feed water heater, with a shorter flow, and is placed over the top of the down-flow tubes as shown in Fig. 2. Ample pro-

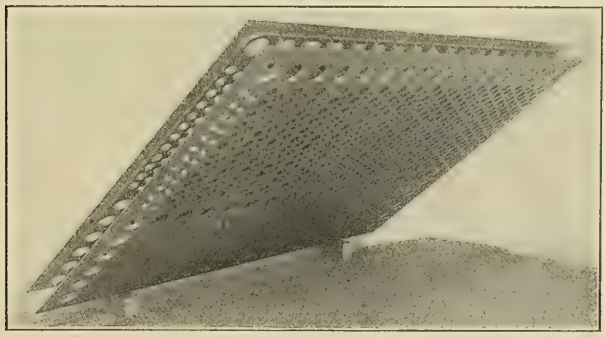


FIG. 3

vision for expansion, cleaning and renewals of the feed and superheater tubes, insures the most efficient and satisfactory results. By-pass valves are fitted on the heaters, permitting either, or both, to be cut out in case of emergency.

The casing is sectional and lined with asbestos fire felt 2 inches thick. The furnace in Fig. 1 is entirely surrounded by the large side tubes and the flitches. The furnace door openings are circular and welded into the plates. Special fire

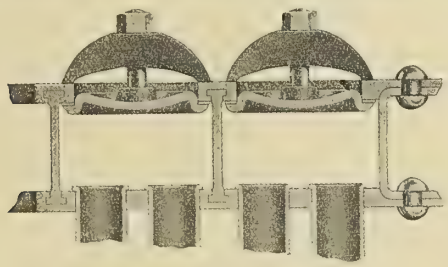


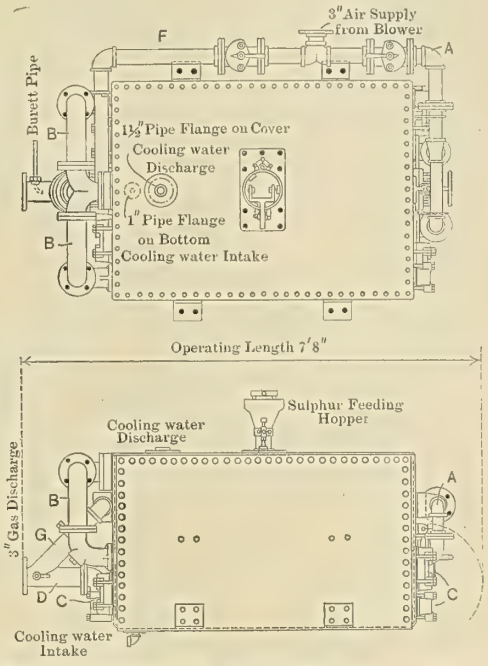
FIG. 4

brick, formed to fit around the outside of the side tubes, form the sides of the casing and are held in place by the sectional casing. In Fig. 2, the flitches do not extend below the tubes, and the furnace walls are of regular fire brick. The boiler is carried independently of the furnace walls, which can be rebuilt without disturbing either boiler or casing.

A Fire Extinguishing Apparatus

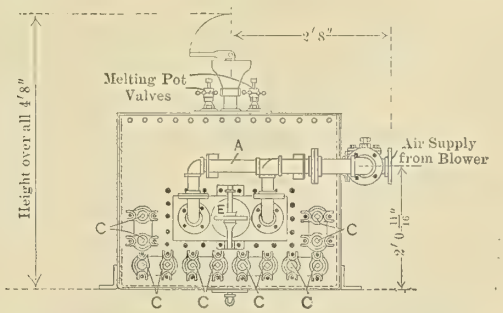
The problem of extinguishing a fire on shipboard as well as preventing one is a serious matter, because of the usual inaccessibility of most fires which occur in the cargo. Fire has smouldered for days and weeks in a ship's hold, while the crew have been unable to put it out. Especially so in cargoes of hemp, jute, bituminous coal and like substances. Steam may damage cargo and, under certain conditions, may help combustion. The ideal form of extinguisher in an inclosed space like the hold of a ship is a gas which displaces the air by its own specific gravity, and is itself a non-supporter of oxygen. This gas is found in sulphur dioxide, made when needed from ordinary commercial sulphur. An apparatus for generating sulphur dioxide has been placed on the market by the Fumigating and Fire Extinguishing Company of America, 29 Broadway, New York.

This apparatus, which may be used both for fumigating purposes and for extinguishing fires, consists essentially of a furnace, a blower and an engine. The whole apparatus may be located in a deck house or in any convenient position, or the blower and engine, with a tank for storing compressed air, may be placed in the engine room under the immediate care of the engineer.



PLAN AND ELEVATION OF FIRE EXTINGUISHING APPARATUS

The furnace in which the sulphur dioxide gas is generated is built on the principle of a marine boiler. As shown by the drawings, the outside is a rectangular tank, within which is a furnace. Sulphur is admitted into a melting pot in the furnace through a charging hopper on top of the apparatus. Two valves on each side of the hopper are used to regulate the admission of the melted sulphur from the melting pot into



FRONT END VIEW OF FIRE EXTINGUISHING APPARATUS

the furnace. Compressed air is carried to the furnace through pipe *A*, which connects with two perforated pipes in the furnace. The gas formed from the air and sulphur is conveyed from the top of the furnace through pipe *B*, and then passes back and forth through tubes *C*, which are surrounded by the water circulating in the outer jacket around the tubes and furnace. After the gas is cooled by passing through tubes *C* it is discharged through the pipe *D*, and is carried through a hose or pipe to its destination.

When starting the furnace, the door, *E*, at the end, is opened and alcohol-soaked waste is placed in the furnace and ignited. The door is then closed and remains closed throughout the operation of the furnace. As soon as the door is closed the compressed air is turned on, part of it being admitted to the furnace through pipe *A*, and the rest being by-passed through

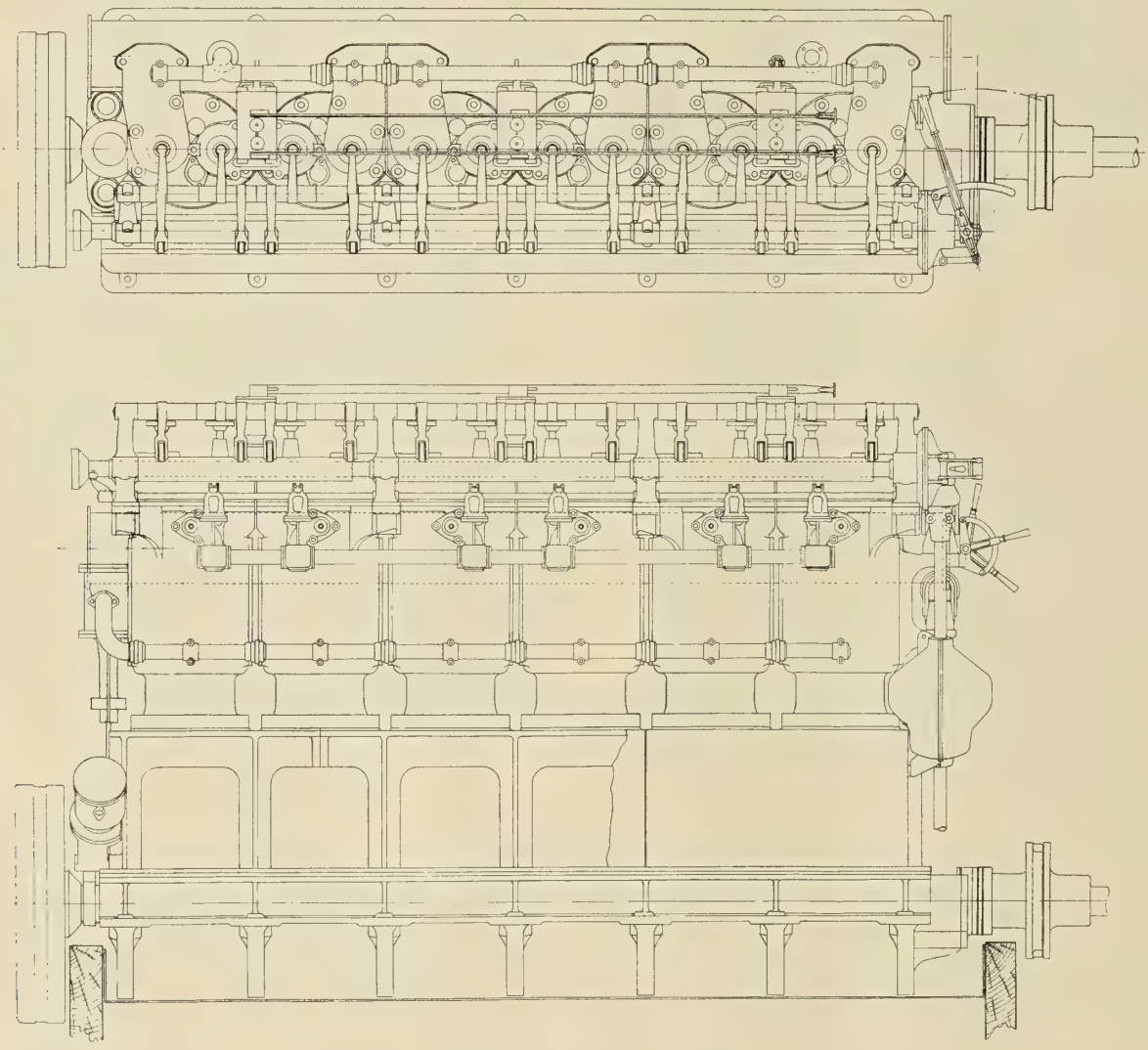
pipe *F* to the gas discharge pipe at *G*, thus acting as an injector and drawing the products of combustion from the furnace. After about two minutes complete combustion is obtained in the furnace, and then all of the compressed air is pumped directly into the furnace through pipe *A*, so that within five minutes after starting the furnace a gas containing 6 percent sulphur can be obtained.

Samples of the gas can be taken from the burett pipe, shown in the drawing, so that the furnace can be regulated to give the proper quality of gas desired.

From the above it will be seen that during the operation of the furnace the gas is cooled to about the temperature of the atmosphere, and leaves the furnace cool, dry and under pressure. It is completely under control, so that it can be made of a quality or density to suit a fire-extinguishing or a fumigating case, as may be required. Furthermore, the pumping apparatus is not brought in contact with the gas, since the air is furnished under pressure before passing through the furnace. Therefore there can be no deterioration of the blower on account of contact with sulphur dioxide. Once the apparatus is started, the sulphur is fed through the hopper, so there is no opportunity for the escape of gas fumes. The principal advantages of this machine are that it furnishes almost immediately a positive fire extinguishing gas which will penetrate every part of the hold without damage, as well as furnishing means for freeing a ship of disease germs and vermin. It has been approved by the United States Steamboat Inspection Service, Department of Commerce and Labor, and installations are to be made on the five new large American-Hawaiian steamships now under construction at the Maryland Steel Company, Sparrows Point, Md.

The Rumely Marine Oil Engine

The accompanying line drawing illustrates a 6-cylinder, 9 inch by 12 inch compressed air starting and reversing Rumely marine oil engine, rated at 125 brake-horsepower, the smallest of a line of large heavy-duty marine engines, built principally for mercantile marine service and for large yachts. The fuel used is preferably the ordinary grades of kerosene (paraffin) obtainable at practically all the ports of the world at from three to seven cents (½ to 3½ pence) per gallon. The lower grades of fuel oil, it is claimed, however, have been used very successfully, involving no alteration in engine or carbureters, and incurring no special difficulties. The normal brake-horsepower rating of all the Rumely engines is very conservative, the maximum brake-horsepower output at rated revolutions per minute being in all cases at least 20 percent in excess of the normal brake-horsepower rating, thus insuring utmost reliability of service.

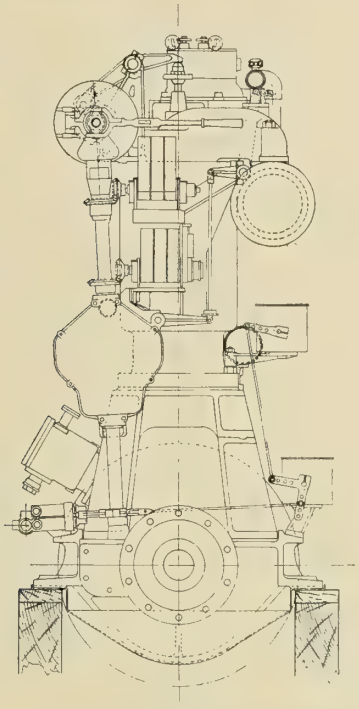


125-HORSEPOWER RUMLEY OIL ENGINE

The engines are designed and built for practically continuous operation at full load under the rigorous conditions

of operation usually found in the mercantile marine field. Correct valve timing, for both the ahead and reverse motions, is assured through the application of two independent and complete sets of cams, all mounted on one cam-shaft, either being shifted into action at will by moving the cam-shaft endwise. Starting, either ahead or reverse, is positively accomplished by admitting highly compressed air to each of the six cylinders in proper rotation, on the explosion strokes only, through mechanically operated valves. This allows each cylinder to draw its proper charge of carburetted air through its respective carbureter and to compress these charges, entirely unaffectd by the action of the compressed air. The compressed air having once set the engine in motion, either ahead or reverse, continues to operate it until the charges drawn in during the suction strokes have become properly carburetted to ignite at the tripping of the spark. The engine then immediately takes up its gas engine cycle automatically, and uses no more compressed air thereafter, even though the operator may still hold the starting valve open. When maneuvering, the engine is claimed to be as positive in its action as any steam engine.

Three carbureters are applied, one to each two cylinders, and no pre-heated air or fuel charges, hot plates, bulbs or tubes are resorted to, nor are any high-pressure fuel pumps or compressed air applied to secure proper atomization of the oil



END VIEW OF RUMLEY OIL ENGINE

charges. The carbureters are designed to thoroughly atomize an exactly proportioned fuel charge and a small quantity of water, at each inspiration, directly into the engine cylinder, together with a thoroughly intermixed air charge which is varied automatically to suit each change of load or speed. The heat of the interior of the engine cylinder, after the engine has been initially started on gasoline (petrol), together with the heat of compression, flashes the minutely divided particles of fuel, each surrounded by air, into a perfectly homogeneous, unstratified explosive mixture, a condition which insures thorough and proper combustion of the fuel and the highest mean effective pressure after explosion. During the beginning (or high pressure and high temperature portion) of the explosion stroke, the atomized water is disassociated into its chemical components (oxygen and hydrogen), the heat absorbed in the process effectively lowering the maximum temperature at the beginning of the stroke, but this heat is regained by the chemical recombination of the water components during combustion, and thus increases the existing cylinder pressures at a point in the crank travel where it can act to greater efficiency in producing turning moment.

Indicator cards show comparatively low maximum explosion pressures, a remarkably full expansion line due to the recombination of the oxygen and hydrogen, which raises the mean effective pressure to 95 pounds, and produces an engine remarkably free from the shocks of explosion, and which is therefore conducive to smooth running. The fuel consumption is claimed to be .9 pint per brake-horsepower hour.

Combustion spaces, cylinders, pistons, valves and igniters, it is claimed, are as free from carbon deposits as in the best gasoline (petrol) engine practice, due to the thorough atomization of the oil charges at all loads, the absence of hot plates, bulbs, tubes, etc., and their attendant oil splitting and stratification of the charges, and to the scouring or scavenging action of the oxygen component of the admitted water. No splash lubrication is applied, all cylinders and bearings being positively lubricated at all times in direct proportion to the engine speed, by means of force-feed mechanical oilers, not more than one bearing being oiled from one feed. Centrifugal ring oilers are applied to all crank-pins.

The crank-shaft, which is of 40-point carbon steel, has seven main bearings. The sub-base is of rigid I beam and channel construction, of cast iron in one piece, and is designed to allow of the removal of any one or more bearing brasses, upper and lower, without disturbing the others. This construction also admits of realining all bearings without removing the crank-shaft, and permits the entire removal of the crank-shaft itself from the engine, within the fore and aft length of the engine, without dismantling the cylinders. The intermediate base is of the open crankcase construction, thus permitting instant inspection of the cranks and bearings merely by pulling aside light sheet-iron covers or splash doors, without the use of tools of any kind.

Cylinders and cylinder heads are cast separately, and any cylinder head may be removed without taking down the cam-shaft. No water is passed through the gaskets, it being by-passed in outside water channels where a possible leak can do no harm and can be fixed at the end of a run. Removal of a cylinder head does not involve the resetting of valves, igniters, etc., when replaced. All the valves are mechanically operated, and the cam-shaft drive is spiral. An inlet suction muffler deadens the hissing of the intake, and is arranged to draw all piston gas leakage from the base into the cylinders and out the exhaust.

Two independent systems of ignition in each cylinder are applied, one a substantial mechanical make-and-break system operating on a low-tension Bosch magneto and a suitable battery for starting, the other a Bosch magnetic make-and-break system. These may be used either independently or in synchronism with the aid of a tachometer.

The rotative speed of the engine, 350 revolutions per minute normally, may be varied throughout a wide range by means of the hand-controlled variable speed governor, which acts on the carbureter throttles. Thus, in a heavy seaway, the speed of the engine remains within a few percent of whatever the conditions may require. All control handles for reversing, compressed air starting, both magnetos, batteries, governor, etc., are grouped conveniently at the after end of the engine and within a 14-inch circle, and no long reaching nor heavy pulling is ever required of the operator.

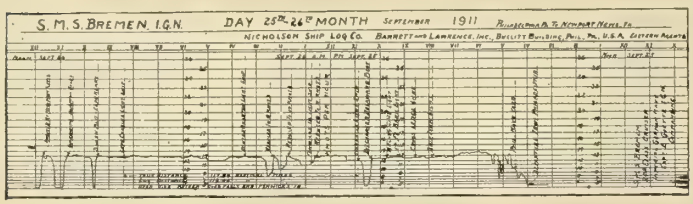
A slip coupling is provided which may be quickly loosened, without allowing the engine and propeller shafts to get out of alinement. This clutch permits easy resetting of the valves; warming up of the engine or operating the engine for any other reason when the craft is tied up to her moorings, or

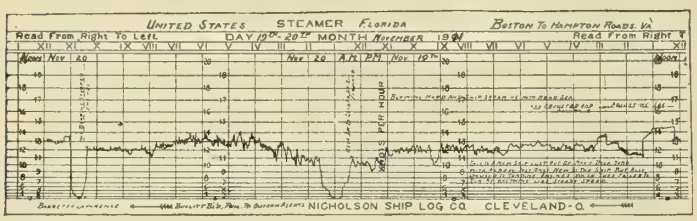
used for auxiliary purposes on a sailing vessel. An air compresser for providing for starting, and other auxiliary purposes is built on the forward end of the engine. This air compresser is automatically cut out of action when the required pressure is reached, and put in again when the pressure drops. A large double-acting phosphor bronze circulating pump geared down to 70 revolutions per minute when the engine is running at 350 revolutions per minute is also built rigidly to the forward end of the engine.

These engines are manufactured by the M. Rumely Company, of La Porte, Indiana.

The Nicholson Ship Log and Automatic Speed Recorder

The ship log manufactured by the Nicholson Ship Log Company, Cleveland, Ohio, has been described in previous issues of INTERNATIONAL MARINE ENGINEERING. The advantages of this instrument lie in the fact that it is located on the bridge or in the chart house where the captain himself can see it, where it not only gives him the distance run but enables him to see at a glance just what effect head winds and rough water have on his ship, while the record card automatically logs graphically any change that may be made for any cause whatever. The device operates by a pressure tube on the bottom of the ship, and therefore requires no trailing line




UNITED STATES STEAMER FLORIDA
BOSTON TO HAMPTON ROADS, VA.
Read From Right To Left
DAY 19TH-20TH MONTH NOVEMBER 1911
Read From Right
NICHOLSON SHIP LOG CO. CLEVELAND-O.

astern; and is just as accurate and reliable in the confined waters of a river, bay or sound as it is in the open sea.

We are publishing herewith, by courtesy of Barrett & Lawrence, Inc., Philadelphia, Pa., Eastern representatives of the Nicholson Company, two record cards, which we regret we had to reduce very greatly, but we believe the readers of INTERNATIONAL MARINE ENGINEERING will find most interesting; one was made by the German cruiser *Bremen* between Philadelphia and Newport News, Va., and the other by the U. S. S. *Florida* between Boston and Hampton Roads.

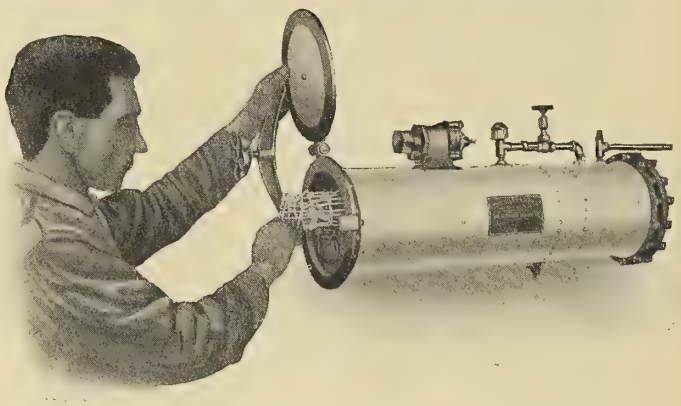
The first named ship is driven by reciprocating engines, and it will be noted how steady her speed is, the only departures being those deliberately made for discharging or taking on pilots, quarantine, or slowing for passing vessels.

The *Florida* is a turbine-driven ship and the crew were not only new to the ship (which was just out of a navy yard) but were as yet unused to turbine engines, which they failed to run at anything like steady speed. It is only fair, however, to say that for the first eighteen hours shown by this *Florida* card the weather was exceptionally heavy, as is borne out by the fact that shortly after midnight she had to be hove to for over an hour to better secure the ship forward.

On the earlier turbine ships in the navy, notably on the *Chester*, where this instrument was first put on board, the speed was very irregular, and the cards were used to steady down the firing, with such success that within a few days they succeeded in producing almost perfect regularity of speed and have been doing so for the whole three and one-half years that they have had the instrument, with a very marked economy in fuel.

Steam Acetylene Generator

The latest device for the production of acetylene gas for marine uses is an acetylene generator which utilizes steam. The steam generator is cylindrical in form, an average size being 10 inches in diameter by 42 inches long, and having a



carbide capacity of 25 pounds. Steam of any pressure is connected to this apparatus, and the gas is made as and when required. In an ordinary water-to-carbide acetylene generator, one drop of water is the smallest quantity which can be fed at one time, but in this form this is attenuated over 1,600 times; the consequence is that the moisture for the dissolution of the carbide is admitted in an almost infinitesimal quantity, and as the steam is instantly converted into gas its generation is practically uniform, regardless of the volume being used. The quantity of steam necessary to operate this generator is so slight as to be practically negligible, carbide as a rule being readily decomposed by the moisture in the ordinary atmosphere.

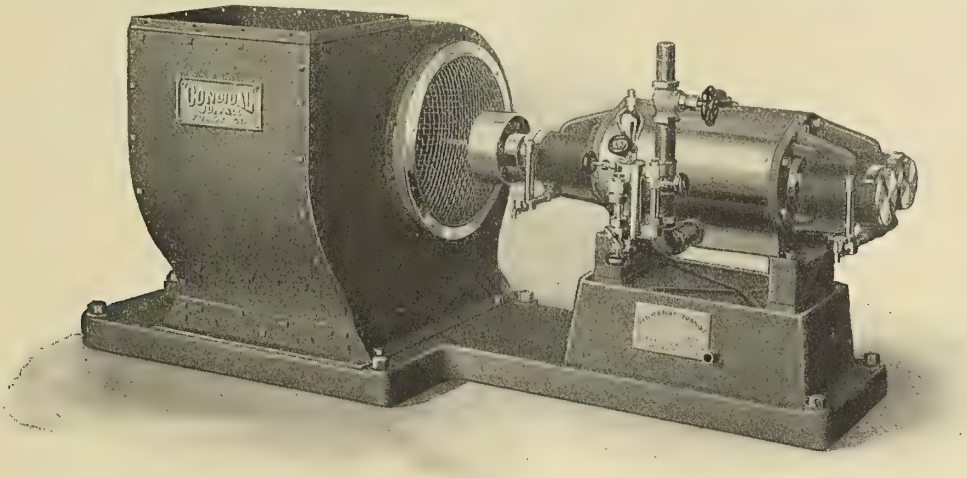
The steam acetylene generator is made of a welded steel cylinder, galvanized after made, and comprises two chambers, one chamber for the carbide and one to wash and purify the gas. The carbide chamber is divided, one section for the carbide and one into which the residue drops as the gas is made. The residue is not a wet, sluggy matter, as is the case with water-to-carbide or carbide-to-water machines, but is an absolutely dry powder from which all the gas has been extracted. There is very little mechanism in connection with this device, a metal diaphragm allowing the entrance of the steam in such a manner that the internal pressure of the gas controls its own manufacture, this pressure being uniformly maintained at all times after the machine is set in operation.

The steam generator is absolutely safe, as in case of fire there is practically no gas stored within it, neither is there sufficient internal pressure to take serious account of, the average working pressure not exceeding one pound. In case the pressure should rise to a higher point there is a simple water-seal relief which will carry the gas off through a vent pipe into the open air. The generator is also claimed to be absolutely unaffected by heat, vibration or movements of any kind.

Its immediate application to steamships is the lighting of searchlights, signal lights and for interior illumination, and it is obvious that it is particularly valuable for steam tugs and all steam craft, steam-hoisting derricks, shovels, dredges, etc., where a large electric plant is not in use. Its cost of operation is very low in comparison with the cost of other lights. The manufacturers are The Alexander Milburn Company, Baltimore, Md.

A New Development in Steam Turbines

A strikingly new type of combined impulse and reaction turbine, christened the "Spiro," has been put in the market by the Buffalo Forge Company, Buffalo, N. Y. It is the invention of Mr. John H. Van Deventer, superintendent of this company. The principle of its design and operation is seen at a glance from the two runners with herring-bone teeth.



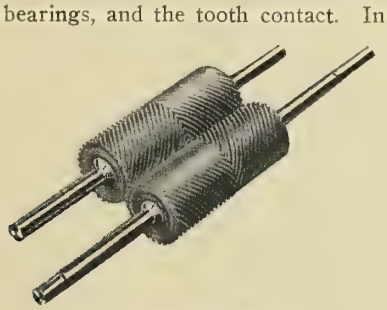
25-INCH "CONOIDAL" FAN DRIVEN BY A 10-HORSEPOWER SPIRO TURBINE

The steam impinges in the central pocket formed by the juncture of the teeth.

The construction of the turbine is extremely simple. It consists essentially of five parts—the case, two heads with bearings, and two rotors. These rotors consist simply of helical gears, cut by special machinery, without any loose or inserted blades. The steam action within the pockets formed by these spiral gear teeth is theoretically perfect, making full use of the impact of the fluid due to its velocity, and avoiding the leakage usually found in turbines, which is the chief cause of their lack of mechanical efficiency.

The "Spiro" is at present manufactured in sizes from 1 to 50 horsepower, non-condensing, and patterns are being rapidly completed for an extension of sizes up to 300 horsepower.

There are but two points of wear in the "Spiro" turbine, namely, the bearings, and the tooth contact. In the bearings



SPIRO RUNNERS

the lubricating system is so designed that each bearing acts as an individual oil pump, circulating oil through the bearing between shaft and bushing, with a positive pressure. This forms a perfect oil film, and as long as there is any oil in the reservoirs, or oil chambers which form part of each bearing, this oil film is automatically maintained. Thus there is absolutely no metal-to-metal contact in the bearings, all the contact coming upon the oil film.

The tooth contact is said to be very satisfactory. The helical gears are the most perfect known for high-speed service, smoothly running and of strength far beyond the requirements. The length of the spiral rotors in the "Spiro" is much greater than would be necessary for the face of spiral gears transmitting equal loads at equal speeds, and as a result the maximum tooth pressure per square inch is limited to 5 pounds, while ten times that amount would be conservative for long-wearing power transmitting gears. It has also been discovered that a film or cushion of steam is at all times maintained between the teeth of the rotors, which causes an elastic contact sufficient to produce great smoothness of action.

The economy of this type of turbine has been found from tests to be as good as that for reciprocating engines of corresponding size, which, coupled with the fact that the power is obtained from a machine occupying a small space and of light weight, makes it of particular value for driving marine auxiliaries.

Personal

Kingsley Gould Martin has become associated with Ray D. Lillibridge, Inc., 192 Broadway, New York, as engineer and writer. Mr. Martin has also been elected treasurer of this corporation.

Prof. Harold A. Everett, of the Massachusetts Institute of Technology, Boston, Mass., has been appointed by the Eastern Yacht Club Regatta Committee as official measurer for all the yacht clubs in Boston Bay.

Albert H. Ziegler, who for six years was chief draftsman and designing engineer of the Standard Motor Construction Company, Jersey City, N. J., is now designing and consulting marine engineer for the M. Rumely Company, La Porte, Ind., a concern which is just beginning the manufacture of large internal-combustion engines for mercantile marine service. While with the Standard Motor Construction Company last spring, Mr. Ziegler designed two 300-horsepower lightweight racing engines for a 40-foot hydroplane now building at the Electric Launch Works, Bayonne, N. J., as a defender for the coming Harmsworth Trophy Race. These engines are now on the test stand, and will probably figure prominently in the forthcoming racing season.

Obituary

Walter A. Post, president of the Newport News Shipbuilding & Dry Dock Company, and of the Old Dominion Land Company, Newport News, Va., died suddenly on Feb. 12, aged 55 years. Eleven months ago Mr. Post succeeded the late Calvin B. Orcutt as president of the Newport News Shipbuilding & Dry Dock Company, of which he was formerly general

manager. Mr. Post was born in Kingston, N. Y., and in 1880 he went to Newport News to take charge of the construction of the Chesapeake & Ohio Railroad terminals. Ten years later, as civil engineer, he superintended the erection and equipment of the Newport News Shipbuilding plant for the late C. P. Huntington. The death of Mr. Post is a distressing calamity, not only to shipbuilding interests but to general business interests. Few could have more friends than he had. In the business world his place can hardly be filled, because of his rare personality, which commanded universal admiration, and, what was very exceptional, the affection held for him by those who have spent the best years of their lives working with and under him.

Francis H. Stillman, president of the Watson-Stillman Company, New York, and a prominent figure in machine tool and engineering industries, died suddenly, Feb. 18, in Brooklyn. Mr. Stillman, who was 62 years old, was a Yale graduate. On leaving college he was first associated with the Cottrell Printing Press Company, then with his stepfather, Mr. Lyons. In 1883 he organized and became president of the firm of Watson-Stillman, which succeeded Lyons & Company. The firm was incorporated in 1904 as the Watson-Stillman Company, Mr. Stillman remaining its president up to the time of his death. He was a member of the Hanover Club of Brooklyn, the Engineers' Club of New York, the American Society of Mechanical Engineers, and treasurer of the National Association of Manufacturers. He organized and was first president of the Machinery Club of New York, and was also first president of the National Metal Trades Association. In addition to being president of the Watson-Stillman Company at the time of his death, he was also president of the Bridgeport Motor Company and of the Pequannock Commercial Company, and a director in other manufacturing firms. Mr. Stillman's affable disposition, high standard of business integrity and kind personal interest in all those with whom he came in contact won for him a large circle of friends that will keenly regret their loss in his death.

Technical Publication

Verbal Notes and Sketches for Marine Engineers. Seventh Edition. By J. W. Sothern. Size, 6 by 9 inches. Pages, 631. Illustrations, 515. Glasgow, 1911: James Munro & Company. Price, 10/6 net; $5.00.

This volume is the seventh edition of a book containing notes and sketches of verbal and elementary questions given at the Board of Trade examinations to engineers competing for first-class and second-class certificates of competency. In this edition the original work has been practically rewritten and re-illustrated, several hundred new and original sketches being included. The work includes sections devoted to workshop practice, boilers, notes and sketches of various details, slide valves, piston valves, valve data, general notes and descriptions, marine engineering chemistry notes, marine electric lighting, propellers, refrigeration and internal-combustion engines. The section devoted to boilers has received particular attention, practical examples of the applications of the rules of design, etc., being explained and worked out. The section treating with workshop practice is new and contains material which is difficult to find in any other publication. As has been true in previous editions of this work the practical side of marine engineering has received chief attention.

A chart, 14 by 28 inches, showing a longitudinal view of the interior of a modern submarine boat has been published by the Norman W. Henley Publishing Company, 132 Nassau street, New York. Every detail is shown accurately to scale and 200 parts are numbered and named in an accompanying reference list. The price is 25 cents.

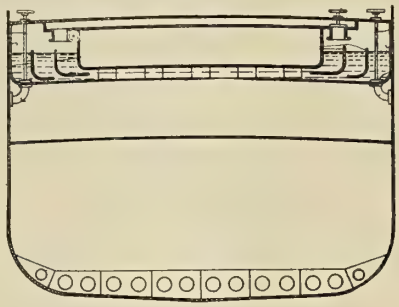
Selected Marine Patents

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

1,007,348. MEANS FOR DAMPING THE ROLLING MOTION OF SHIPS. HERMANN FRAHM, OF HAMBURG, GERMANY.

Claim 2.—In a ship having a U-shaped water chamber arranged transversely thereof and comprising side tanks connected together by a water conduit, said water chamber being adapted to damp the rolling motions of the ship; means for preventing impacts and disturbation of the water



in the water chamber during the rolling motion of the ship an for effecting a uniform rise of the water in the side tanks, comprising bent guide-plates adapted to divide the water flowing from the water conduit into the side tanks into a plurality of streams and said bent guide-plates directing the water upwardly in the side tanks. Four claims.

1,008,532. PRIME MOVER FOR MARINE PROPULSION. CHARLES G. CURTIS, OF NEW YORK, N. Y., AND RALPH L. LOVELL, OF QUINCY, MASS.

Claim 1.—In a prime mover for marine propulsion, the combination of a reciprocating steam engine and a steam turbine, directly coupled to the same shaft, receiving the steam in succession and adapted to utilize the complete expansion of the steam. Thirteen claims.

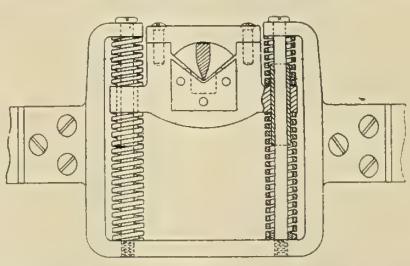
1,008,726. FLUID-PRESSURE POWER PLANT. LUTHER D. LOVEKIN, OF OVERBROOK, PA., ASSIGNOR TO GERARD DEVELOPMENT COMPANY, OF NEW YORK, N. Y., A CORPORATION OF NEW YORK.

Claim 1.—In combination, a rotary expansion engine comprising a casing, a rotary piston therein cleared from the casing, a multi-stage turbine separate and distinct from the rotary expansion engine, said engine and turbine being mounted on separate shafts disconnected from each other, and means whereby the steam driving the piston of the rotary expansion engine and passing the cleared portions thereof is exhausted into the turbine. Two claims.

British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C. London.

29,414. SUSPENSION FOR MARINERS' COMPASSES. KELVIN AND JAMES WHITE, LTD., AND F. W. CLARK, GLASGOW.

According to this invention, the knife edges of the compass bowl are made of non-magnetic hard steel or other specially hard metal and co-



operate with V-jewels such as ruby or agate stone, the knife edges and jewels being slightly curved. The jewel block is encased in a sliding piece connected to shock absorbing springs.

27,728. MEANS FOR CLEARING SCALE FROM MARINE CONDENSER TUBES. T. G. BARRON, STOCKTON-ON-TEES.

In this invention rollers mounted in pairs are employed, one pair, for instance, in the vertical plane mounted in angle irons and another pair in the horizontal plane mounted on standards. Each roller has a groove such that when the device is at work the passage between a pair of grooves is elongated or varied from the true circle. By gearing the vertical pair together their synchronous rotation, the requisite grip on the tube and its consequent passage under treatment is provided for. By these means the tube is compressed in one direction to crack and dislocate the scale and then passed through the other pair of rollers, which compress it in another direction for the same purpose.